ROADS And STREETS

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Snow Plow Working on Ohio State Route 252 at Olmsted Falls

SNOW AND ICE
Some Observations on Good and Bad Practices In Winter Maintenance

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ICE and snow on the highways! How often have these two menaces to travel caused sleepless nights and made gray hair grow on the heads of those responsible for keeping public roads both safe and passable! To many it may seem that these hazards are just plain nuisances—in fact "headaches"—and one wonders just how many highway officials have realized that a successful fight against them will, instead of being an expense, be a source of revenue.

Gasoline Sales vs. Cost of Open Roads.—How much would normal travel be curtailed during winter if the traveler was sure that pavements would be reasonably clear and safe? Certainly all travel of a commercial nature would keep on in undiminished volume. Recreational or pleasure driving, to be sure, would be reduced somewhat, but not nearly to the extent it now is on most of the highways in this country.

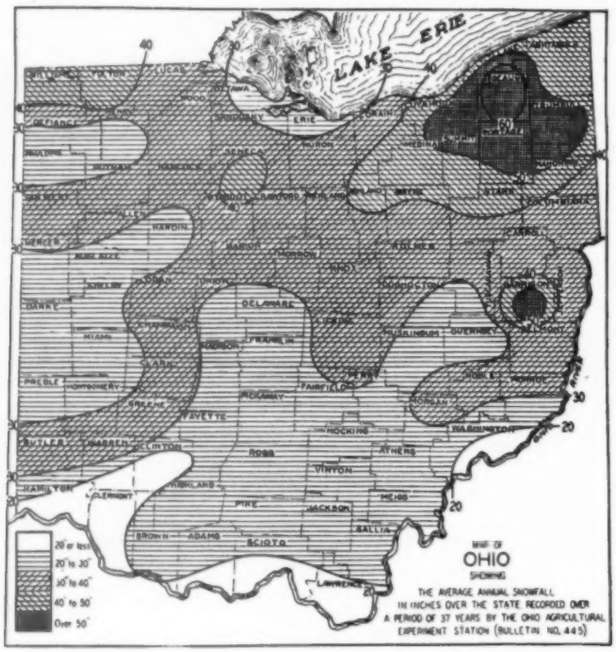
Thorough protection of the motorist and truck hauler against the hazards of ice and snow should result in gasoline tax revenues of January and February falling very little, if any, below those of November, December, March and April. A check-up of gasoline consumption during these months will show that in most cases the cost of fighting ice and snow falls a long way short of the difference in revenues for fall and spring as compared to winter. When traffic surveys are made with this problem in mind, data will be available which will conclusively prove this point.

The actual problem of successfully fighting the ice and snow menace naturally falls into two divisions, viz.: "Icy Pavement Protection" and "Snow Removal." These problems involve the use of different equipment and of course somewhat different methods.

How Snow Problems Are Met in Ohio

The problem of the snow hazard involves the actual removal of snow from our highways and the prevention of drifts. Prevention of drifts in Ohio is handled in the conventional manner, using snow fence usually placed 75 to 150 ft. from the pavement on the prevailing windward side. Not much thought has been given to the planting of hedges or shrubbery for this purpose in connection with beautification projects. However, this method of snow drift prevention will, no doubt, be given more thought as landscaping, or roadside development, becomes more adjusted to the practical needs of our highways.

The snow removal problem when reduced to its fundamentals is simply one of getting the right equipment to work at the right time. This is, or would be, no problem if the highway department had unlimited funds or enough equipment for peak requirements. To put it another way, who would worry much about getting the snow off if there were a truck plow stationed every 5 miles along the highway? One may venture to say that there are not many, if any, highway depart-



Map of Ohio Showing Average Annual Snowfall

ments so favorably equipped. Their problem, therefore, is how to get equipped to produce the best results within their means.

A study of the accompanying map will show that in Ohio approximately two-thirds of the state has an annual snowfall of from 20 to 40 in. From an equipment standpoint the problem resolves itself into providing for three regions, viz.: the small, heavy snowfall area which incidentally is also the most densely populated, the large, medium snowfall area, and the light snowfall area.

Methods and Equipment in Areas of Medium Snowfall.—The medium snow area is our largest. In this area, after years of only mediocre results, it was "discovered" that the way to fight snow was to get a large number of small plow units to work as soon as a storm started; then keep up with the storm. Some of our maintenance engineers in this area were insisting on being equipped with large heavy truck plows. Recently these same men, much to their dismay, were supplied with about twice as many small one-way plows to be attached to 1½ ton trucks. After one winter with this equipment the most stubborn were thoroughly "sold" on the small, fast-plowing unit. In this large middle area it is felt that one light, fast truck plow unit for each 20 to 30 miles of road to be plowed will insure prompt and satisfactory snow removal. In fact we have found that one light plow can effectively take care of twice as many miles of road as a heavy plow. At the present time we have one plow for approximately each 35 miles of road in this middle area. This includes both light and heavy units. Attention to little things, such as seeing that each unit is equipped with lanterns, extra tire chains, jacks, tow cables, emergency gasoline supply, etc., before it starts out, have often made the difference between good and bad snow removal.

In the Heavy Snowfall Area.—The problem in the heavy snow area is similar except that it has been found necessary to supplement the light plow equipment with heavy truck plow units capable of bucking drifts and opening up heavy snows. It is there that the "V" plows have found their place. After opening up a drift, the one way plow seems to be the only unit that will successfully widen out the lane for two way traffic. The lighter units follow up or take care of roads not subject to much drifting. In this area we have approximately one plow for each 20 miles of highway.

As the present time the department owns 6 rotary plows. These, however, are seldom, used, being taken out only when exceptionally heavy drifts occur. I have not counted them as regular equipment. We find that the rotary plow is ideal to buck into a large, heavy snow drift, but we also find that if the light plows start out and do their work early drifts seldom get so deep as to require the use of a rotary in Ohio.

Where Snow is Light.—The light snow area is equipped with fewer plows, and here even motor patrol graders are considered as plowing equipment. These graders, though slow, are effective in this area especially on the light traffic roads. We have, in this territory, approximately one plow for each 50 miles of road maintained, grades not being included in this count.

Special Lighting on Plowing Units.—The number of accidents incidental to snow plowing operations carried on after dark shows the need for standard and effective lighting of snow plowing units. This matter is being studied, and will be worked out more effectively this year. In the meantime, one superintendent has developed a very satisfactory system of lighting, consisting of spotlights directed in front of the plow, lights illuminating the plow and truck itself, and a number of red lights indicating the width of the equipment. The illustration shows this arrangement.

The small lights on the ends of the projecting rods indicate the necessary clearance to drivers approaching from either direction, there being one such set of lights in front and another at the rear. The front clearance lights, and also the spotlights, being mounted at cab top level, are above the flying snow when the plow is working. Illumination of the truck body affords further protection by showing clearly the character of the equipment.

In addition to these lights, we generally hang 4 red lanterns on the rear of the truck to correspond with standard tractor and trailer illumination in this state and indicate a slower vehicle than a car or standard truck.

Special Lighting Equipment for Snow Plow Truck

Personnel and Organization.—The best of equipment will be of no use unless careful thought is given to proper organization of personnel. A rapid means of notifying the men and getting work started at any time of day or night is essential. This seems so elemental that one is surprised that it is so often overlooked. It only need be said that all men who operate plowing units should be required to have telephones, and, that the supervisor or superintendent of maintenance should have enough extras subject to call that he never need be caught short handed. Two men are always sent out with each unit. When it is necessary to plow for more than 12 or 14 hours at a stretch, reserve forces are

called from the regular maintenance organization. Should still another relief crew be needed, it too is immediately available, as we have built up in this organization 3 sets of 2 men for each plowing unit. However, it is only in the longest continued storms that we need to call out 3 successive crews.

When Ice Comes

The other winter menace, icy pavements, is, in Ohio especially, a more difficult one to handle. This problem is, of course, complicated by the fact that in addition to requiring good personnel and suitable equipment, it calls for the use of large quantities of abrasive material. Protection of the motorist on icy pavements, when reduced to its fundamentals is simply a matter of transporting and spreading a large quantity of abrasive material on hundreds of miles of pavements in the shortest possible time. Some efforts are being made (and successfully under some conditions) to remove the ice itself rather than cover it with abrasives.

Those of our maintenance engineers who have come to look at the icy pavement problem simply as one of transporting material in the shortest possible time from storage to road, have met this problem most successfully. Here again it can easily be seen that if there were plenty of equipment and material available the problem would be no problem at all. It's the same old story of doing the most with limited resources.

Cinder Loading Bin Proves Big Help.—One of our engineers was able to get as much work out of one

Cindering Truck Ready to Start Out. Note the Four Red Lanterns—Also the Rear Clearance Lights on Projecting Arms

truck operated efficiently as out of three operated in the average, or conventional, manner. He realized that in spreading cinders on icy pavements, when a truck was loaded from a stock pile by hand, and cinders were spread from the truck by hand, the truck was working less than one-half the time. He therefore constructed a cinder storage bin so that trucks could be loaded from a chute; then with the trucks equipped with spreaders, one truck would spend 70 to 80 per cent of the time hauling instead of 20 per cent by the old hand load and spread method.

Various Abrasives Require Various Spreaders.—For a number of years mechanical spreaders have been used with more or less success in Ohio for spreading abrasive materials. However, mechanical spreading has been far from perfect. The problem in this state is no doubt similar to that of numbers of others. It is not possible, practical or economical to use only one abrasive. Here cinders, sand, stone screenings, slag screenings and even coal mine slack are all used. Experience has shown that no one type of spreader successfully spreads such

Spreading Cinders on State Route 43 at Solon

extremes of materials as uncrushed cinders on the one hand, and damp or wet stone dust or sand on the other.

We find under general conditions that 5 cu. yd. of abrasive material will treat effectively one mile of road. At times, under ideal conditions, we have used considerably less, but our general average is close to this figure.

It has been found that the spreader that works well on uncrushed cinders does poorly on wet sand and vice versa. Therefore it has been found necessary to supply each locality with the type of spreader best suited to the abrasive which is to be used. The revolving cylinder type of spreader works well with sand or an evenly sized abrasive, while the spinning disc types are best for cinders or unevenly sized abrasives.

The Handicap of Poorly Coordinated Equipment.—It has been our experience that very often spreaders are not used because of complicated or unhandy means of hitching to trucks, or what is worse, very often the man operating the truck, with the best of intention, goes to get the spreader only to find his truck fixed to hook up to another type of spreader, which may be in the next county! Too much care cannot be given to getting the right type of spreader or spreading device for the abrasive to be used, seeing that all the trucks are equipped to hook up to the particular spreaders they are to be used with, and that this is done *before* the ice forms on the pavements.

Mechanical Spreading is Economical.—In Ohio it has been proved to our satisfaction that mechanical spreading is both economical and efficient. Abrasives when spread mechanically cover from three to five times as many miles of road as when spread by hand. We at-

Cinder Bin on U. S. Route 40. Bin is Loaded by Dump Trucks from the Top. It Serves 20 Miles of 20 and 30 ft. Pavement

Spreading Cinders on State Route 8 at Bedford

tempt to protect approximately 2,000 miles of our principal roads by continuous abrasive treatment when covered with ice. The balance of the system (10,000 miles) we only attempt to treat selectively at curves, grades, crossing, intersections, etc. This work will be done more successfully as we provide ourselves with additional strategically located storage bins for quick loading, or adopt other more efficient methods.

About 150 spreaders are used on the 2,000 miles which we regularly treat for ice. It is customary to send out 3 men with each spreader unit—one truck driver and 2 to help with the spreading.

How Abrasives Are Kept from Freezing.—It may be mentioned here that it is standard practice to protect storage piles of abrasives against freezing by treating them with calcium chloride either in flake form or as a liquid. The amount of calcium chloride required for this purpose varies considerably with the locality, inasmuch as we have very large temperature differences in this state. In those parts where temperatures do not get very low we have found that as little as 50 lb. per cu. yd. is effective. In districts of extremely low temperatures, on the other hand, we have used as much as 100 lb. Probably 75 lb. per cu. yd. is a fair average.

Direct Thawing of Ice.—Experiments with a calcium chloride solution sprayed directly on the icy pavement have proved successful where the ice is thin, the solution for this purpose being made with 50 lb. of calcium chloride to 50 gal. of water. This strength has been reduced somewhat for very thin ice. About 200 gal. of the solution is used per mile of 20 ft. pavement. The effect is to thaw the ice so that in a few minutes it can be completely removed from the road by a motor patrol grader.

For spraying equipment, we have used a gravity spray bar attached to an oil drum—a mere makeshift device for work which is in too experimental a stage to warrant standardization.

Spreading Cinders on State Route 43 at Solon

This method has important possibilities, and deserves further experimentation—particularly in its application to thicker ice coatings. There is no question but that it would be more satisfactory to remove the ice completely, if this can be done economically and quickly, instead of covering it with abrasive material.

In certain critical locations calcium chloride or refuse salt is spread directly on the surface to thaw the ice, but this practice is not general.

In conclusion it appears that snow and ice are a long way from "licked," and that there is plenty of room for improvement in methods, equipment and organizations. Properly handled, this work will reap returns in excess of money handled, to say nothing of the reduction of injuries and property damage that will result.

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12,000,000 Tons—Two-Thirds of California's Farm Produce—Hauled by Trucks

The importance of motor trucking as an outstanding factor in the farming industry of California is revealed by statistics assembled by the Department of Public Works. Approximately 12,000,000 tons, or two-thirds, of the state's agricultural production, moved by truck during 1932.

Out of a total of 1,051,000 tons of agricultural and animal products delivered in the Los Angeles markets in 1933, 83 per cent arrived by truck. And of 424,000 tons of similar shipments to the San Francisco market, approximately two-thirds were delivered by truck.

The monthly receipts in Los Angeles varied from 58,516 tons in January to 93,037 tons in August, not including 200,000 tons of hay received by truck in the southern city. In San Francisco the minimum tonnage in any one month was 15,644 tons in February and the maximum was 30,909 tons in July.

South Favors Trucks.—Forty-eight counties shipped agricultural and animal products by truck to Los Angeles and 52 counties shipped to San Francisco. In Los Angeles, 11 counties contributed 95 per cent of the total truck receipts and in San Francisco 17 counties accounted for 91.24 per cent of the total truck tonnage. A further analysis of live stock movements shows that the Los Angeles market favors the truck more generally than do shippers into San Francisco. In both places, trucks are preferred for the movement of calves and hogs, while sheep are shipped primarily by rail.

San Francisco Exception.—In each market, the majority of the stock from nearby counties is trucked in. Thus, Los Angeles County is the largest producer for the Los Angeles market. Practically all of its cattle are trucked in. Similarly, Marin, Alameda and Santa Clara counties, which are nearby sources for the San Francisco market, also favor the use of trucks for their stock movements. However, in the case of San Francisco there is a notable exception. From Solano County, also nearby and the second largest source of supply, trucking is negligible.—*California Highways and Public Works, August,* 1935.

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Scientific Speed Traps.—A newspaper dispatch of Aug. 16 from Amherst, Mass, says: "Speeders beware! Professors of Massachusetts State College have invented an electric device that times automobiles more accurately than stop watches. With photo-electric cells, this portable machine measures the time required for an automobile to pass parallel light beams thrown across the street at a distance of 18 in. apart." The article adds that the device translates its record into miles per hour, but does not state that it arrests speeders.

MACHINES FIGHT SNOW IN MANY PLACES

This is the first of a collection of views showing snow removal equipment in action. The second installment will appear in October.

Clearing a 12-Inch Snow at Bath, Maine, in March, 1935. The Equipment, a Baker Tripping Blade Truck Plow, Is Owned by the City

At Oroville-Quincy Summit in the California Sierras. A Le Tourneau Angeldozer Mounted on an Allis-Chalmers Model L Tractor Is Opening Up This Mountain Road.

Two Views Taken at the Height of a Bad Storm. Work in Progress on U. S. Route 1 near Chadd's Ford, Pennsylvania, January 23, 1935. Goods Roads Champion Model 30, Reversible Blade Plow with Flare Plate Attachment Mounted on Autocar Truck. Fast Falling Snow Made Poor Photography.

Plowing Through a 13-Inch Snow on Sedalia 12-Mile Special Road District, Pettis County, Missouri. A J. D. Adams Snow Plow Mounted on the Front of an Adams Motor Grader Owned by the District.

Clearing a Factory Yard. This Machine, a Trackson High Shovel, While Designed Primarily for Loading Trucks from Piles or Windrows, Also Did Its Own Plowing.

After the Storm of January 23, 1935, on U. S. Route 1, About 33 Miles South of Philadelphia. Large Plows Were Used to Widen Here—Blade Plows to Clear—Trimming Up Was Done by Hand.

New England Is Snow Country. A La Plant-Choate V-Type Plow Propelled by Caterpillar Diesel 40 Tractor. Clearing a road in Maine After the Storm of April 5, 1935.

This Snow Had Been Packed Down for Three Weeks. A 22-Horsepower Cletrac Sidewalk Plow Opening Things Up.

Opening Up Truck Roads in Fond du Lac County, Wis., March 11, 1935, When Drifts Were 5 and 6 Feet Deep. An Allis-Chalmers 50-Horsepower Model K Tractor Behind a Wausau V Type Plow with Wings.

On an Ohio Hillside. A Burch Corporation Ross V Type Plow Cutting Through a Heavy Drift

Prairie Snow Controlled by Fence. A Large Drift Has Accumulated Between Fence and Highway. Fence Made by Illinois Wire and Manufacturing Co.

Even Washington, D. C., Has Snow Problems. Here Is a Street in the Capital City Being Cleared by a Snow King Model 56 Loading and Widening Plow.

Clearing Park Sidewalks at Racine, Wis. A J. I. Case Model "CI" Tractor Operating a Detroit Rotary Brush After the Storm of March, 1935. Equipment Owned by Racine Park Board.

Winter Maintenance in Bucyrus, Ohio. A W. A. Riddell Standard Motor Grader Equipped with Warco V-Type Plow, and with J. and S. Traction Treads on Rear Wheels.

Gas Shovel on the Job at Haverhill, Mass., Following Storm of March, 1935. This Was a Heavy Duty Model 1020 Bucyrus-Erie Owned by the Haverhill Street Department. For This Service It Could Have Been Equipped with a Dipper of Lighter Construction and Several Times Greater Capacity.

CALIFORNIA HIGHWAYS AND A RECORD SNOW STORM

Successful Fight by State Forces on 4,500 Miles of Road

By GEORGE F. HILLESOE and NELSON T. BANGERT
Assistant Maintenance Engineers, California Division of Highways

AFTER having enjoyed a winter of exceptionally light snowfall last year (1933-1934), the maintenance forces of the State Division of Highways were once again pressed to the limit in keeping snow area routes open to traffic. Exceeding in intensity and area any storm experienced since the department inaugurated the policy of keeping open all important roads, the "season's worst storm" started on January 7, 1935, reached its peak between January thirteenth and eighteenth, and did not subside until January twenty.

The range of the storm was exceptional, with 4 in. of snow falling at Eureka, where a measurable depth is seen only once in a generation, to a maximum fall at "Old Reliable," Donner Summit, where in four days the snow pack was increased by 88 in. The manner in which the men of the fighting forces responded to the emergency in conquering the "Snow King" is indeed a credit to the organization and must in all sense give them the satisfaction of a job well done.

The following abstract from a district report of the storm amply characterizes the manner in which the employes responded:

"During the storm, superintendents, foremen, and leadingmen lost all track of days and hours. Truck drivers and equipment operators took their equipment out and kept it moving until a round trip was made, or until they were relieved."

Clearing a Six Foot Fall Between Dunsumuir and Mt. Shasta City, North End of State

The storm, conceded in places to be the worst in 12 years was general throughout the state, and deposited snow in measurable depths to the 1,200-ft. level in the north and to the 4,000-ft. level in the south. Adding to the fierceness of the storm was the accompanying wind, more particularly in the Sierras and the east of the Sierra region, reaching at times a hurricane velocity of 60 miles an hour. Coupled with temperatures which in places ranged to 30 degrees below zero, the storm, for a time, gave the state more of the arctic touch than is attained in ordinary winters.

New and Adequate Equipment Saves Situation.—Fortified with the best layout of equipment yet available since the advent of snow removal totalling some 293 pieces, and ranging from "V" push plow motor graders to large augerblower type rotaries, the department was able to keep open to traffic 4,500 miles of road on which the snow pack reached a foot or more in depth. In addition, many tow graders, tractors, and power graders were pressed into the service of clearing lighter falls.

Equipment was not allowed to stop, operation being continuous in places for as much as 175 hours, with only time out for servicing. A vital help during the emergency was the equipment purchased last fall to replace obsolete units. Broken equipment was repaired and put back into operation with the least possible delay, repairs at times being made at night in a snow bank with only the aid of a flashlight.

Where Snow Fence Would Have Helped.—As usual, the greatest trouble was experienced at points unprotected by forest or snow fence. Howling winds reformed drifts on roads almost as rapidly as they were cleared. The value of the drift fence already installed was very evident and demonstrated the necessity of additional installations.

Falling Trees Add Trouble.—In District I, where ordinarily snow removal is a minor problem, the snowfall reached a maximum of 104 in. on Oregon Mountain, a record fall for that location. In the heavy timbered areas, the weight of snow brought down many large trees which further impeded snow removal operations. Along Willow Creek, 62 trees fell across a two-mile section of highway. Some of these trees were of such size as to necessitate the use of powder in their removal.

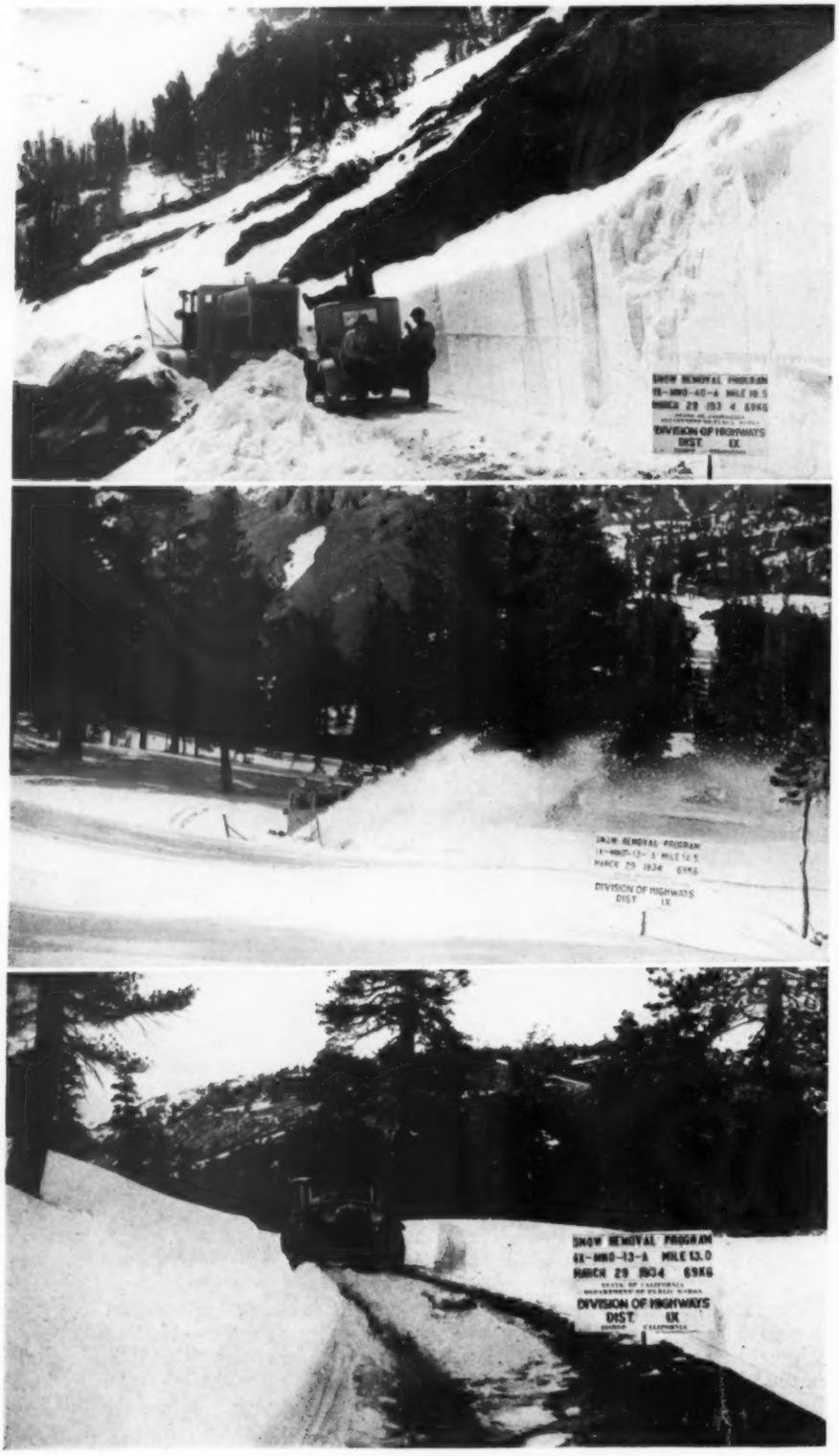
Except for a small area in Tehama County, snow removal was necessary on all highways in District II. While the snowfall did not reach record depths at any place in this district, the storm was unusual in that snow fell every day from January 3 to January 20. The greatest trouble was experienced in the high-plateau sections east of the mountains, where high winds and resulting drifts were responsible for the blocking of several roads for short periods.

The Toughest Job of the Winter.—U. S. Route 40, from Colfax over Donner Summit to the Nevada State line, was the most difficult route in the state to keep open, largely on account of drifting snow. On this section, ten 4-wheel-drive trucks with push-plow attachment, three auger-blowers, and one railroad type

rotary plow were operated.

With this equipment working constantly, the road was kept open, although for five days, on account of restricted width, it was necessary to close the road to trucks and to convoy light traffic over the summit under patrol car control. During this period, it was necessary to allow less important roads in the vicinity to close. These were opened again as soon as equipment could be released from the main route.

Almost as difficult as the Donner route was that portion of the "East of the Sierra Highway," Route 23, in District IX. On 140 miles, from the Nevada State line to Bishop, three summits are crossed, ranging up to 8,100 ft. in elevation. The snow at this altitude is dry and light, and when driven by strong gales necessitates the continuance of snow removal operations long after the actual fall of snow has ceased. Seven truck push-plows and two auger-blower type rotary plows were used to keep this road open to traffic.



Three Views in District IX in the High Sierras After the Storm

A Snow Fall of One Foot Per Hour.—In comparison with a season's fall of 138 in. for last year and 96 in. for the year previous, the fall to date at Deadman's Summit has amounted to 164 in. During the worst of the storm, snow fell at the rate of from 2 to 54 in. a day; the maximum rate of fall being as high as a foot an hour.

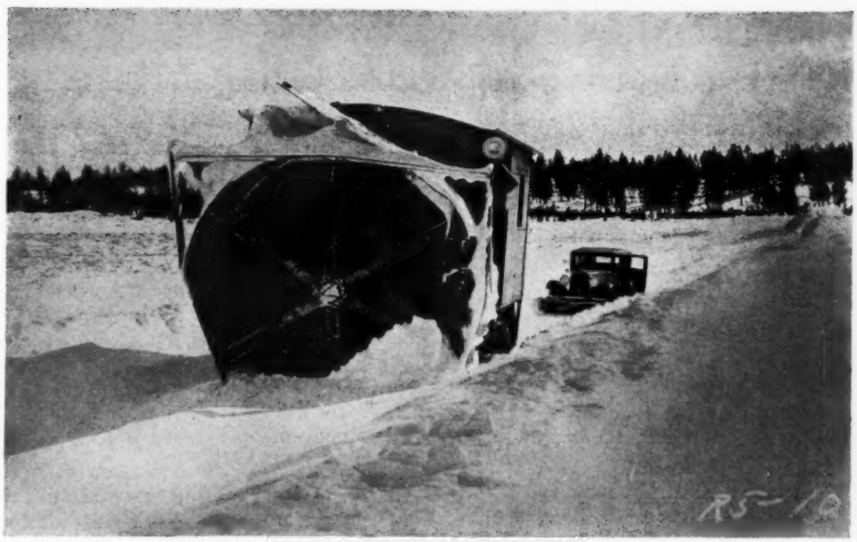
Where Snow Fence Did Help.—Long stretches of snow fence have been installed at points where drifting was extremely serious. To date some 9 miles of fence, ranging from 4 to 12 ft. in height, protects the highway. Comprehensive surveys indicate that 31 miles of additional fence will be required to adequately control the relentless action of the wind. Past storms in this region indicated the natural slope of snow behind fences to be about 7 to 1. The high winds of this season have caused drift slopes as great as 14 to 1.

Traffic Is Controlled During Storm Periods.—At times when blizzards are raging over certain sections of the route, passage by inexperienced motorists would be extremely hazardous if not impossible. To forestall the possibility of parties becoming snowbound in the area, the flow of traffic is controlled by gates. During the winter season, control stations are established at Crosby's, 16 miles north of Bishop, and at Leevining. Only those engaged in snow removal operations or those familiar with the country are allowed in this area during storm periods. During the recent big storm, conditions dictated the closing of the road to general traffic for a period of five days.

Snow of high moisture content tested the ability of road forces in charge of the highways radiating easterly in the Sierras from Fresno and the Mother Lode country. Two rotary type and 9 push plows were used in keeping these roads open. The maximum snowfall occurred on the Calaveras Big Trees route and amounted to 60 in.

Cleared Highways Take Thousands to Winter Sports.—A heavy fall of snow in the Sierra Madre Mountains back of Los Angeles made necessary the use of all available equipment in order to clear the mountain highways for the throngs of snow sport enthusiasts. During the week end of January 19-20, 5,000 cars, representing some 20,000 people, wound their way over snow-cleared highways to Los Angeles County's recreational area at Big Pine Park.

Similar conditions prevailed in the San Bernardino Mountains where throngs of valley residents surged to the famous Lake Arrowhead and Big Bear resorts for a day in the snow. Long hours of toil on the part of the highway crews were necessary to insure their safe and carefree journey.



Coleman Plow North of June Lake Junction

Even in San Diego County at the south end of the state, winter brought its mantle of white to the higher mountain areas. Snow equipment, inactive last year, was assembled and roads cleared without difficulty.

The great influx of motorists into the snow areas again justified the program of snow removal on mountain highways. On the Sunday following the storm, 430 machines traveled over Donner Summit, 487 used Route 15 east of Nevada City, and almost 2,000 machines used state highways into the Cuyamaca State Park near San Diego to enjoy the snow sports. None of these highways could have been used were it not for the department's policy of snow removal.

Snow Plow Clearing the Tahoe-Ukiah Lateral

Acknowledgment.—The foregoing account is taken from *California Highway and Public Works.* We are indebted to the California Division of Highways for the illustrations used.

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There were just as many careless drivers 30 years ago, but the horses had more sense.

Uniform Limits on Vehicle Size Urged for Europe

The Continent's mass of motoring regulations—each country has its own idea of how things should be done—are proving a stumbling block. An effort is to be made to straighten things out somewhat.

For instance, Germany limits the width of heavy-duty commercial vehicles, carrying loads up to seven tons, to 2m 50cm. In France, the limit of width has recently been reduced from this figure to 2m 35cm. Belgium sets the limit at 2m 40cm. The diversity of maximum permissible width, a matter of capacity in which manufacturers want to give the user the fullest load space possible, makes things difficult for factories.

It is suggested in Belgium that some uniform standard should be adopted. This principle has long been recognized as essential to progress. Whitworth standard threads, metric threads, wheel and tire sizes, and many other standards, have been generally accepted and have reduced confusion to simplicity.—*Natal Mercury, Durban, S. A.*

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Sign Vandals Endanger Drivers

A wave of sign vandalism resulting in destruction of public property and danger to motorists was reported in August by the Minnesota State Highway Department. In nearly all sections of the state maintenance crews on the trunk highways are finding an unusual number of road signs defaced.

In some instances the vandals even have used wrenches to unbolt heavy warning signs, and in other cases they have spent much labor in pulling sign posts out of the ground bodily. Hunters also destroy many markers by using them for shotgun targets.

"Signs warning motorists of dangerous turns and curves and giving load limits on small bridges are among those which have been defaced," said N. W. Elsberg, highway commissioner. "If the persons who seem to enjoy this type of vandalism could visualize the automobile accidents and human suffering which are likely to result, they would turn their energies to other channels."

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1st Powderman: "What caused the explosion at your house?"

2nd Powderman: "Powder on my coat sleeve."

ORGANIZATION OF CONSTRUCTION EQUIPMENT ASSOCIATION

As this issue of ROADS AND STREETS goes to press a new association of construction equipment manufacturers is being formed for the purpose of maintaining the great equipment industry on a firm and proper footing in all respects, and especially to prevent a return to objectionable conditions which existed in the industry during the years immediately preceding 1934.

Members of the organizing committee report that response to this letter has been most enthusiastic, and another meeting is to be called about Sept. 10.

This development is the outgrowth of a meeting of a large group of manufacturers held in Chicago on July 18. At that meeting, the following organizing committee was appointed:

Chairman, S. F. Beatty, Austin-Western Road Machinery Co.; Morgan Butler, Butler Bin Co.; C. L. Dunham, Sullivan Machinery Co.; George M. Etnyre, E. D. Etnyre Co.; W. B. Greene, Barber-Greene Co.; O. G. Mandt, Jaeger Machine Co.; J. R. McGiffert, Clyde Iron Works; Wm. Parrish, International Harvester Co.; L. W. Yerk, Pioneer Gravel Equipment Manufacturing Co.

The committee has established headquarters at 410 North Michigan Ave., Chicago, and is proceeding rapidly with its work. Following are quotations from a statement issued by it on Aug. 8:

"The plan contemplates the affiliation of the membership of all existing trade associations and organized groups of manufacturers in the Industry, and individual manufacturers not so organized, with the proposed Construction Equipment Association, and that a close affiliation shall be established with the Associated Equipment Distributors. It is hoped that the restrictions to membership in the A. E. D. will be so modified that all vendors of construction equipment may become members of it and thereby become affiliates of the proposed Construction Equipment Association."

"The cost of membership in the proposed association shall be kept at a minimum, and shall be set forth in a budget which will be submitted to the membership before final adoption. It is contemplated that the cost shall not be burdensome upon any member."

Among the announced objects of the Construction Equipment Association are:

"To set up fair methods of competition as far as laws will permit, which are fundamental and applicable in all parts of the Industry but which do not conflict with Fair Trade Practices approved by an existing Trade Association or organized group in the Industry, and to afford a place where complaints alleging violation of such fair trade practices may be filed by members of the association or its affiliated distributors."

"To act in the arbitration of differences which may arise between members of the Industry or its affiliates."

"To act as a clearing house for the interchange of credit information maintained on a voluntary basis and available to all members of the Industry or its affiliates."

"To collect information, gather statistics, and work out analyses when required."

"To conduct a campaign of education among members of the Industry and the affiliated distributors with the object of procuring voluntary adherence to fair methods of competition without the necessity of resorting to compulsory methods."

"To defend the Industry and any of its component groups or affiliations from discrimination or aggression, and to encourage legislation which will tend to improve conditions in the Industry, and to oppose any legislation found detrimental thereto."

"To cooperate in improving the relations between the manufacturers, distributors and consumers."

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Road Show to Be Held in Cleveland

Definite decision has been made by the American Road Builders' Association to hold an "Old Fashioned" Road Show concurrently with the annual convention next Jan. 20-24, and Cleveland has been selected as the Convention-Road Show city.

Formal announcement of the convention and Road Show plans was made from Washington by William P. McDonald, president of the Association, after the Board of Directors acted upon the recommendation of the Joint Convention and Exhibit Committee. Mr. McDonald disclosed that the Joint Committee conducted a poll among manufacturers and producers of highway equipment and materials and found sentiment overwhelmingly in favor of resuming the Road Show.

Preference expressed by the manufacturers and producers as to the Convention-Road Show city gave Cleveland a considerable majority, but Chicago, St. Louis and other mid-Western cities also had supporters. Cleveland has been conducting an active campaign to get the event, especially if the A. R. B. A. decided to hold the Road Show. Many of the manufacturers and producers expressed favor of Cleveland because of the availability of that city's new Exhibition Hall, which was designed particularly to accommodate exhibits at the Road Show.

The new exhibit area, in one building, is 461 ft. long and 365 ft. wide, making the total exhibit space available 160,000 sq. ft. This very nearly equals the space area occupied in Cleveland during the shows of 1928 and 1929 which completely filled three buildings.

Officials of the A. R. B. A. disclosed that preliminary plans are well advanced to hold a convention that will cover all major phases of the highway industry and profession, and to present a Road Show of all-inclusive magnitude. There has not been a Road Show since 1933, and the great advances that have been made in technical phases of equipment and materials have developed a strong demand for an "Old Fashioned Road Show where the trade can see everything under one roof."

The convention program, like the Road Show, will be in keeping with the "1936 model," it was declared by the A. R. B. A. officials, and the subject matter scheduled for discussion will be as broad in scope as the whole industry and profession, with nationally-known engineers, highway officials, contractors, manufacturers, producers, and others who know highways and streets leading the discussions.

▼

Hudson Tunnel Rushed

The Port of New York Authority has reported to the Public Works Administration that the new $37,500,000 midtown vehicular tunnel under the Hudson River between New York City and New Jersey is expected to "hole through in September, 1935, breaking all construction records for this type of work." The construction shield, which was started through the slit of the river bed from the New Jersey shore last September, was reported moving forward at the rate of 35 ft. a day. It now is well past midstream and working toward a similar shield.

PERFORMANCE OF KEY EQUIPMENT USED IN HIGHWAY CONSTRUCTION

By T. C. THEE

Associate Highway Engineer,
Division of Management, Bureau of Public Roads

Concrete Pavers, Power Shovels, Elevating Graders and Asphaltic Concrete Mixers are treated in a series of studies of performance reported by Mr. T. C. Thee of the U. S. Bureau of Public Roads. The first of this series—that relating to concrete pavers—appeared in the August issue of ROADS AND STREETS; *the studies on power shovels are given herewith; and the two remaining items will be presented in October.*

The Power Shovel

Tables II to III-C, inclusive, summarize results of a portion of the studies made of power shovel operation on grading jobs in the Midwest and Western States. The jobs studied in the Middle West and the West are referred to as Jobs A and Jobs B, respectively.

The average size of shovel studied on Jobs A and B were 1.172 and 1.349 cu. yd., respectively. The actual average dipper load was 0.774 and 0.850 cu. yd.; the average angle of swing was 82.7 and 107.7 degrees; and the average shovel cycle was 22.74 and 23.03 seconds per dipper and 29.38 and 27.09 seconds per cubic yard respectively for Jobs A and B.

If the shovels could have operated without delays, 122.54 and 132.85 cu. yd. an hour could have been excavated. While actually operating, 80.17 and 93.90 cu. yd. of material was excavated on Jobs A and B, respectively.

The shovels operated without delay 55.52 per cent of the available working time on Jobs A and 58.76 per cent on Jobs B. The percent of the available working time spent in loading the dipper was 20.60 and 23.01 per cent, indicating the amount of time consumed in swinging the shovel with the dipper load, dumping the dipper, and returning the dipper again to loading position.

Minor delays caused 29.33 and 24.38 per cent of the available working time to be lost on Jobs A and B, respectively, and the major delays were 15.13 and 16.86 per cent.

Fig. 5—Drilling and Blasting Operations Must Be Advanced, Planned and the Rock Blasted Sufficiently (See Above) to Enable the Shovel to Secure a Full Bite in One Pass

Unavoidable delays were 28.13 and 32.41 per cent and the avoidable delays were 16.35 and 18.83 per cent, showing that better management was used on Jobs B.

Tables II-A and III-A classify the time losses which occurred on Jobs A and B. The time lost due to weather was 9.20 and 11.40 per cent. Obviously weather delays are generally not so large for shovel grading jobs as for other types of construction. Shovel operation, especially in rock excavation, can be carried on more uniformly without large time losses due to weather than any other type of highway construction.

Causes of Larger Major Delays. — Shovel repair, shovel engine trouble, and moving the shovel from cut to cut or within a cut cause the larger major delays. Time lost due to shovel repair was large especially when the shovels operated in poorly blasted rock. Engine trouble and shovel repair during operating hours can be materially reduced by constant inspection of the shovel by a competent mechanic. Moving the shovel from cut to cut is a necessary time loss; however, it can be the source of considerable loss especially if this operation is not carefully planned in advance.

TABLE II.—SUMMARY OF SHOVEL OPERATION AND TIME LOSSES

	Jobs A Middlewestern Shovels	Jobs B Western Shovels
Total cubic yards excavated	571,628	1,017,553
Size of shovel in cubic yards	1.172	1.349
Dipper load in cubic yards	0.774	0.850
Angle of swing in degrees	82.7	107.7
Cubic yards per hour with no delays	122.54	132.85
Cubic yards per hour with minor delays	80.17	93.90

Average Shovel Cycle

	Seconds Per Dipper	Cu.Yd.	Per Cent	Seconds Per Dipper	Cu.Yd.	Per Cent
Load	8.44	10.90	37.11	9.02	10.61	39.17
Swing	5.83	7.53	25.64	5.95	7.00	25.83
Dump	2.64	3.40	11.61	1.83	2.15	7.95
Return	5.83	7.53	25.64	6.23	7.33	27.05
Total cycle	22.74	29.38	100.00	23.03	27.09	100.00

Utilization of the Available Working Time

	Hours	Per Cent	Hours	Per Cent
Load	1731.17	20.60	2999.90	23.01
Swing	1196.09	14.23	1978.87	15.18
Dump	541.60	6.46	608.62	4.67
Return	1196.09	14.23	2072.00	15.90
Time shovel operated with no delays	4664.95	55.52	7659.59	58.75
Minor unavoidable delays	1374.25	16.35	2297.56	17.69
Minor avoidable delays	1090.93	12.98	879.25	6.75
Time shovel operated with minor delays	7130.13	84.85	10836.40	83.14
Major unavoidable delays	989.91	11.78	1926.54	14.78
Major avoidable delays	283.00	3.37	271.44	2.08
*Available Working Time	8403.04	100.00	13034.38	100.00

*Delays due to weather not included.

TABLE II-A.—CLASSIFICATION OF TIME LOSSES ON POWER SHOVEL GRADING PROJECTS IN THE MIDDLE WEST

Total Study Time.....9254.75 Hours

Time Lost Due to Weather and Wet Grade, etc.

Character	Unavoidable Delays Hours	Unavoidable Delays Per Cent	Avoidable Delays Hours	Avoidable Delays Per Cent	Total Delays Hours	Total Delays Per Cent
Rain	318.00	3.44	.....	....	.....	....
Wet Grade	379.86	4.10	.....	....	.....	....
Misc.	153.85	1.66	.....	....	.....	....
Totals	851.71	9.20	.....	....	851.71	9.20
Available Working Time					8403.04	90.80

Major Delays Occurring During Available Working Time (Delays of More Than Fifteen Minutes Duration)

Moving	167.03	1.99	13.92	0.16	.....	....
Repair Shovel	324.87	3.87	28.63	0.34	.....	....
Engine Trouble	196.41	2.34	12.15	0.14	.....	....
Cable Repairs	38.68	0.46	2.52	0.03	.....	....
Drilling and Blasting.	64.05	0.76	71.95	0.86	.....	....
Rocks, Roots & Stumps	11.79	0.14	1.60	0.02	.....	....
Hauling Supply	0.50	0.00	27.40	0.33	.....	....
Hauling Operation	19.30	0.23	4.37	0.06	.....	....
Supplies	5.58	0.07	18.34	0.22	.....	....
Miscellaneous	161.70	1.92	102.12	1.21	.....	....
Totals	989.91	11.78	283.00	3.37	1272.91	15.15
Time Shovels Actually Operated During Available Working Time					7130.13	84.85

Minor Delays Occurring During Time Shovels Actually Operated (Delays of Less Than Fifteen Minutes—From Stopwatch Studies)

Hauling Supply	67.93	0.95	588.54	8.25	.....	....
Hauling Operation	173.19	2.43	202.61	2.84	.....	....
Move Shovel	397.19	5.57	9.27	0.13	.....	....
Shovel Repairs	99.04	1.39	18.67	0.26	.....	....
Engine Trouble	31.38	0.44	2.71	0.04	.....	....
Operator	13.14	0.18	122.17	1.72	.....	....
Fuel & Water	15.43	0.22	8.52	0.12	.....	....
Sloping	231.28	3.24	59.72	0.84	.....	....
Rocks, Roots & Stumps	247.23	3.47	43.56	0.61	.....	....
Check Grade	9.35	0.13	6.71	0.09	.....	....
Miscellaneous	89.09	1.25	28.45	0.40	.....	....
Totals	1374.25	19.27	1090.93	15.30	2465.18	34.57
Time Shovel Operated at 100% Efficiency					4664.95	65.43
Total of All Avoidable Delays (Class B Delays) (Hours)					1373.93	
Possible Operating Time—Class B Delays Eliminated (Hours)					6038.88	
Efficiency of Power Shovel Operation (Per Cent)						77.25

Fig. 6—Since the Shovel Spends Over 50 Per Cent of the Cycle Time in Swinging It Is Imperative to Keep the Swinging Time at a Minimum by Placing the Shovel on One Side of the Cut, as Shown Above, Rather Than in the Center of the Cut, as shown in Fig. 7

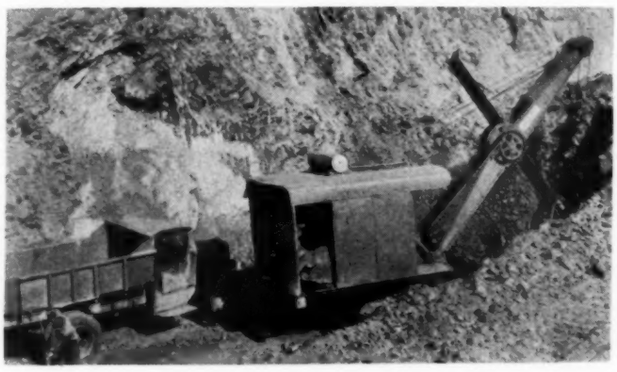

Fig. 7—Shovel in Center of the Cut

The largest avoidable delays were caused by an inadequate supply of hauling units, by the operation of the hauling units, and by the shovel operator. Due to the fact that haul lengths vary almost hourly, it is obviously uneconomical to maintain an exact balance between the hauling equipment supplied and that just needed to maintain the highest rate of production at the shovel. Therefore, the transportation problem on a shovel job becomes one of determining the economical number of hauling units and operating this number so as to maintain as nearly a uniform haul length as conditions will allow. Most contractors employ the method of trial and

TABLE II-B.—SUMMARY OF TIME LOSSES ON POWER SHOVEL GRADING PROJECTS IN THE MIDDLE WEST

Project Number	Per Cent Study Time Lost Due to Weather Wet Grade, etc.	Per Cent Available Working Time Lost Due to Major Delays	Per Cent Available Working Time Shovel Actually Operated	Per Cent Actual Operating Time Lost Due to Minor Delays	Per Cent Available Working Time Shovel Operated With No Time Lost	Per Cent Available Working Time Lost Due to Unavoidable Losses	Per Cent Available Working Time Shovel Lost Due to Avoidable Loss	Overall Efficiency In Per Cent
1A	9.90	14.51	85.49	37.70	53.26	35.38	11.36	82.42
1B	15.70	30.85	69.15	44.80	38.17	33.42	28.41	57.33
2	15.62	23.51	76.48	33.00	51.25	37.53	11.22	82.04
3	13.03	4.08	95.92	21.38	75.41	12.14	12.45	85.83
4	8.74	15.05	84.95	48.22	43.98	27.67	28.35	60.81
5	2.03	8.87	91.13	31.52	62.40	14.88	22.72	73.31
6	5.57	12.51	87.49	35.64	56.31	20.40	23.29	70.74
7A	15.25	10.49	89.51	31.87	60.98	20.73	18.29	76.93
7B	30.12	13.48	86.52	28.45	61.90	25.62	12.48	83.23
7C	4.50	23.67	76.33	33.99	50.38	36.85	12.77	79.77
7D	4.70	5.79	94.21	31.88	64.18	19.37	16.45	79.59
7E	6.46	11.15	88.85	33.56	59.03	27.48	13.49	81.40
8A	3.93	7.31	92.69	23.10	71.28	23.37	5.35	93.01
8B	13.03	9.71	90.29	42.69	51.74	24.76	23.50	68.76
9	2.82	9.62	90.38	28.26	64.84	25.82	9.34	87.41
10A	0.00	8.40	91.60	25.05	68.66	20.49	10.86	86.34
10B	3.47	7.83	92.17	34.42	60.45	25.61	13.94	81.26
10C	0.02	5.93	94.07	25.22	70.35	26.03	3.62	95.11
Averages	9.20	15.15	84.85	34.57	55.52	28.13	16.35	77.25

Fig. 8—A Full Bite in One Pass, Short Cycle of Swing and Instant Dumping Can Only Be Secured Through a Competent Operator Given a Well Maintained Shovel and Proper Spotting of the Hauling Units on the Side of the Shovel, Thus Can Production Be Maintained at a Maximum

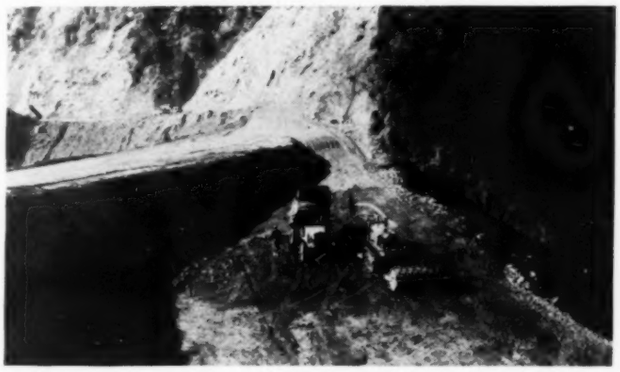

Fig. 9—Hauling Roads as Well as the Fills Under Construction Must Be Adequately Maintained to Expedite the Movement of the Hauling Units

error to arrive at some uniform number of hauling units that may result in the lowest cost. Usually this method is costly.

Advance Planning of Shovel Grading.—In any highway research work an engineer has a very fertile field for making savings; this is especially true in grading work. Developing the time constant and speeds of the hauling units and utilizing the mass diagram or some similar chart or graph, shovel grading can be advance planned so as to keep the combined shovel and hauling unit costs at a minimum. Obviously the designing engineer determines the minimum possible cost of grading operations for a given job. Reducing the average haul positive and material savings can be made and the engineer may reconsider with profit the practice of balanc-

TABLE III-A—CLASSIFICATION OF TIME LOSSES ON WESTERN POWER SHOVEL GRADING PROJECTS

Total study time.....14,711.44 hours

Per Cent of Length of Studies Lost Due to Weather, Wet Subgrade, etc.

Character	Unavoidable Delays Hours	Unavoidable Delays Per Cent	Avoidable Delays Hours	Avoidable Delays Per Cent	Total Delays Hours	Total Delays Per Cent
Rain	898.41	6.11				
Snow	67.45	0.46				
Wet grade	615.40	4.18				
Miscellaneous	96.00	0.65				
Totals	1,677.26	11.40			1,677.26	11.40
Available working time					13,034.18	88.60

Per Cent of Available Working Time Lost Due to Major Delays (Delays of More Than 15 Minutes' Duration)

Moving	336.01	2.58	3.85	0.03		
Shovel repair	831.37	6.38	53.95	0.41		
Engine trouble	22.90	0.18	1.43	0.01		
Cable repairs	38.09	0.29	0.50	0.00		
Drilling and blasting	85.94	0.66	94.73	0.73		
Hauling unit supply	0.50	0.00	9.11	0.07		
Hauling unit oper.	14.54	0.11	5.25	0.04		
Supplies	21.08	0.16	11.38	0.09		
Miscellaneous	576.11	4.42	91.24	0.70		
Totals	1,926.54	14.78	271.44	2.08	2,197.98	16.86
Time shovel actually operated					10,836.20	83.14

Per Cent of Actual Operating Time Lost Due to Minor Delays (Delays of Less Than 15 Minutes' Duration—From Stopwatch Studies)

Hauling unit supply	103.74	0.96	334.90	3.09		
Hauling unit operat	249.44	2.30	224.91	2.08		
Move shovel	527.00	4.86	0.23	0.00		
Shovel repairs	178.49	1.65	1.52	0.01		
Engine trouble	55.96	0.52	25.90	0.24		
Operator	4.01	0.04	113.70	1.05		
Fuel and water	5.30	0.05	6.34	0.06		
Sloping and check gr	459.94	4.24	36.66	0.34		
Rocks, roots, etc	503.59	4.65	43.75	0.40		
Miscellaneous	210.09	1.94	91.34	0.84		
Totals	2,297.56	21.21	879.25	8.11	3,176.81	29.32
Time shovels operated with no time losses					7,659.39	70.68

Total of all avoidable time losses (hours).....1,150.69

Possible operating time with all avoidable losses eliminated (hours).....8,810.08

Efficiency of power shovel operation in per cent..... 86.94

TABLE II-C.—SUMMARY OF HOURLY PRODUCTION ON MIDDLE-WESTERN POWER SHOVEL GRADING JOBS

Job Number	Size of Shovel	Type of Material	Depth of Cut	Ave. Dipper Load	—Average Shovel Cycle in Secs.— Load	Swing	Dump	Return	Total	Angle of Swing	Average Hourly — Production — Actual	No Delays
1-A	⅞	Clay loam, shale, stratified L. S.	8	0.688	10.4	5.1	3.6	6.2	25.3	95	61.0	98.0
1-B	1¼	Fairly well blasted limestone	S. H.	0.788	11.2	5.1	3.5	5.9	25.7	72	61.0	110.5
2	1	Earth and light rock work	3	0.550	11.9	6.5	4.6	6.5	29.5	105	45.1	67.3
3	1	Loose	S. H.	0.915	8.1	5.8	4.5	5.2	23.6	105	109.9	139.9
4	1	Earth per cent well blasted limestone	9	0.845	7.2	10.9	2.6	7.4	28.1	109	55.9	108.1
5	1	Sandy-clay	7	0.692	4.7	5.9	1.7	6.0	18.3	65	93.4	136.5
6	1	Heavy clay	S. H.	0.673	9.4	5.8	3.8	5.6	24.6	73	63.4	98.5
7-A	1	Clay, shale and light rock	S. H.	0.652	7.7	5.5	3.5	5.9	22.6	76	70.7	102.9
7-B	1¼	Wet clay per cent fairly well B. rock	S. H.	0.839	10.7	5.9	3.7	5.6	25.9	65	83.3	116.5
7-C	1¼	Fairly well blasted limestone	10	0.496	10.0	5.7	3.4	5.9	25.0	78	47.2	71.5
7-D	1¼	Well blasted sandstone	15	0.688	8.8	6.9	2.1	7.6	25.4	107	64.6	94.6
7-E	1½	Shale and fairly well B. L. S.	14	0.712	9.5	6.5	2.5	6.5	25.1	104	68.0	102.1
8-A	1¼	Sandy-clay	6	0.962	5.6	4.7	1.0	4.6	15.9	60	167.9	218.1
8-B	1¼	Sandy-clay	5	0.970	6.4	4.8	1.8	5.1	18.1	75	110.6	193.0
9	1	Sandy-clay	10	0.828	6.6	5.0	1.2	4.9	17.8	56	120.3	167.5
10-A	1¼	Sandy-clay and well blasted S. S.	6	0.860	7.4	4.9	1.1	5.1	18.5	47	125.2	167.1
10-B	1¼	Sandy-clay and well blasted S. S.	4	1.030	9.0	4.7	1.8	5.7	21.2	63	114.6	174.9
10-C	1¼	Sandy-clay and well blasted S. S.	8	0.978	8.3	5.1	1.3	5.1	19.8	76	133.1	178.0
Averages	1.172			0.774	8.44	5.83	2.64	5.83	22.74	82.7	80.17	122.54

Total production of all jobs, 571,628 cu. yd.

ing cuts and fills by long end or longitudinal hauls and to visualize what effect the design may have on the output of the key equipment that may be used, keeping in mind, of course, the probable adequacy of the finished highway as paramount.

The shovel operator can make or break a contractor because he is operating a key equipment that in its operation requires skill, good judgment, and clear thinking. Since the number of dippers loaded may be as high as 200 or more per hour, one second lost each cycle represents a large loss of productive time.

Largest Source of Delay.—Unavoidable minor delays are the largest source of delay. These delays amounted to 19.27 and 21.21 per cent of the actual operating time on Jobs A and B, respectively. Moving the shovel so as to get into better position to the face of the cut and also to load the hauling units is a necessary operation and varies with the depth of cut. This delay caused a 5.57 and 4.86 per cent time loss. Another large unavoidable minor delay is that caused by sloping with the shovel and holding up the shovel for brief intervals to check the grade. This delay has been a point of contention in that some consider this operation avoidable and others unavoidable. The time lost due to necessary sloping operations can, however, be negligible if the operator is skilled and experienced and if sufficient guide stakes are furnished him in utilizing the shovel for this operation.

Effects of Poor Blasting on Shovel Cycle.—The time lost due to poorly blasted rock is larger than is apparently shown by the results of the studies. Even though sufficient studies have been made to show the effects of poor blasting on the shovel cycle, the recorded cycle will unavoidably include more time than should be allotted and as a result the apparent loss due to poor blasting operations is not shown directly as a delay. Rock work is costly, especially when the operations of drilling and blasting are not advance planned by skilled foremen who are specialized in this work. Particularly is this work a hazard when the location and the extent of rock is not known. The engineer knows this as well as the contractor. The hazard of rock work was and is counterbalanced by unbalanced bidding when the work is unclassified. Some contractors make their own findings of field conditions by soundings. However, the practice of having the material advertised as unclassified and no information furnished relative to the results of thorough soundings made of the materials that may be encountered, is becoming more and more to be looked on by both the engineer and contractor with disfavor. With a greater appreciation of each other's problems there is becoming a greater meeting of minds to reduce

TABLE III-B—SUMMARY OF TIME LOSSES ON WESTERN POWER SHOVEL GRADING JOBS

Job Number	Per Cent Study Time Lost Due to Weather and Wet Subgrade	Per Cent Available Working Time Lost Due to Major Delays	Per Cent Available Working Time Shovel Actually Operated	Per Cent Actual Operating Time Lost Due to Minor Delays	Per Cent Available Working Time Shovel Operated With No Time Lost	Per Cent Available Working Time Shovel Lost Due to Unavoidable Loss	Per Cent Available Working Time Lost Due to Avoidable Losses	Over-All Efficiency in Per Cent
1-A	0.00	24.24	75.76	44.80	41.82	48.52	9.66	81.24
1-B	0.00	10.86	89.14	35.22	57.75	35.11	7.14	88.99
2-A	0.00	22.65	77.35	34.62	50.57	33.23	16.20	75.74
2-B	0.00	14.51	85.49	37.74	53.22	24.48	22.30	70.48
3-A	11.03	2.15	97.85	17.00	81.21	12.71	6.08	93.04
3-B	11.74	2.36	97.64	19.89	78.22	17.60	4.18	94.93
3-C	8.88	7.90	92.10	21.09	72.67	20.55	6.78	91.47
3-D	6.42	4.95	95.05	15.03	80.76	14.23	5.01	94.16
4-A	9.35	11.86	88.14	24.63	66.43	30.27	3.30	95.27
5-A	0.00	13.28	86.72	22.22	67.45	29.25	3.30	95.34
5-B	30.89	13.66	86.34	32.63	58.17	31.42	10.41	84.81
5-C	29.56	8.04	91.96	26.93	67.19	23.40	9.41	87.71
5-D	6.52	30.67	69.33	36.18	44.24	51.63	4.13	91.47
6-A	4.71	1.07	98.93	22.09	77.07	21.87	1.06	98.65
6-B	6.65	4.38	95.42	23.18	73.30	25.22	1.48	98.01
7-A	10.80	21.13	78.87	29.61	55.52	21.47	23.01	70.70
7-B	0.00	34.66	65.34	24.66	49.22	34.70	16.08	75.38
7-C	0.00	34.15	65.85	33.25	43.97	47.29	8.74	83.42
8-A	11.87	21.30	78.70	28.53	56.41	37.56	6.03	90.34
8-B	0.00	34.87	65.13	24.88	48.94	45.65	5.41	90.84
9-A	34.74	23.41	76.59	37.78	47.67	45.01	7.32	86.70
9-B	29.28	28.46	71.54	33.33	47.69	45.36	6.95	87.28
9-C	31.17	42.04	57.96	26.17	42.79	53.19	4.02	91.41
10-A	36.36	11.80	88.20	28.16	63.36	29.00	7.64	89.25
10-B	15.00	15.08	84.92	31.45	58.21	28.56	13.23	81.47
10-C	0.00	19.39	80.61	27.29	58.61	34.02	7.37	88.83
10-D	20.83	23.16	76.84	30.84	53.14	38.66	8.20	86.64
11-A	6.37	9.25	90.75	39.38	55.01	36.67	8.52	86.87
11-B	0.00	9.91	90.09	34.14	59.33	33.32	7.35	68.98
11-C	12.47	8.53	91.47	39.62	55.23	39.04	5.73	90.60
12-A	0.00	20.98	79.02	42.33	45.57	32.77	21.66	67.78
12-B	0.00	15.51	84.49	36.45	53.69	30.44	13.96	77.19
12-C	5.66	30.01	79.99	54.06	32.15	45.37	22.48	58.87
13-A	10.67	21.34	78.66	31.36	53.99	38.55	7.46	87.85
13-B	4.10	25.59	74.41	30.58	51.66	40.09	8.25	86.23
14-A	2.74	14.33	85.67	27.55	62.07	27.24	10.69	85.30
15-A	17.86	15.33	84.67	31.26	58.30	37.32	4.48	92.86
16-A	0.00	4.53	95.47	27.45	69.27	25.46	5.27	92.93
16-B	0.00	9.31	90.69	36.45	57.64	26.12	16.24	78.02
Averages	11.40	16.86	83.14	29.32	58.76	32.41	8.83	86.94

Study Time—Total length of study.
Available Working Time—Total length of study less weather and wet subgrade delays.
Actual Operating Time—Available working time less all major delays.
Time Paver Operated with No Time Loss—Actual operating time less all minor delays.

hazards in contracting and to allow the practice of good sound management to be the source of revenue for the money invested.

Tables II-C and II-C summarize the production data obtained in the study of the power shovels.

Factor Affecting Shovel Output.—The output of a shovel is affected by the time required to load the dipper, swing, dump, and return. The type and condition of the material to be excavated has a marked effect on the time required to load the dipper. As much as 15 cu. yd. an hour is lost for each additional second spent in loading the dipper. For each additional 10 degrees used in swinging the shovel its capacity is reduced from approximately 15 to 20 cu. yd. an hour. The operation of swinging and returning the shovel consumes over 50 per cent of the shovel cycle time and approximately 30 per cent of the available working time.

The average hourly production of the shovels studied while the shovels actually operated was 80.17 cu. yd. on Jobs A and 93.90 cu. yd. on Jobs B. The average maximum possible output of the shovels if no delays occurred was 122.54 and 132.85 cu. yd. per hour, respectively. The maximum hourly production while the shovels actually operated was 167.9 and 238.0 cu. yd. per hour, respectively. The former production was obtained with a 1¼ cu. yd. shovel operating in sandy clay material at an average swing of 60 degrees, a cycle of 15.9 seconds per dipper with an average of 0.962 cu. yd. of material per dipper load, and an average efficiency of 93.01 per cent. The latter production was obtained with a 1½ cu. yd. shovel operating in good common excavation with an average angle of swing of 46 degrees, a shovel cycle of 15.2 seconds per dipper, and an average of 1.12 cu. yd. of material per dipper load at an average efficiency of 95.27 per cent.

Fig. 10—The Bulldozer Attachment and the Scraper Unit Are Essential Auxiliary Equipment in Handling Material Inaccessible to the Shovel and in and Around the Points Where the Material Is Unloaded from the Hauling Units

However, to obtain good production in any given material for any given conditions a superintendent must appreciate all the factors affecting production and advance plan accordingly and be allowed ample latitude by the contractor in superintending the various operations.

TABLE III-C.—SUMMARY OF HOURLY PRODUCTION ON WESTERN POWER SHOVEL GRADING JOBS

Job No.	Size of Shovel	Type of Material	Depth of Cut	Ave. Dipper Load	Average Shovel Cycle in Seconds					Angle of Swing	Average Hourly Production	
					Load	Swing	Dump	Return	Total		Actual	No Delays
1-A	1½	Fairly Well B. Rock and Earth..	15	0.669	8.8	5.1	1.4	5.6	20.9	110	63.4	114.9
1-B	1¾	Fairly Well B. Rock and Earth..	12	0.668	8.0	5.1	1.5	5.5	20.1	95	75.1	115.9
2-A	1	Poorly Blasted Granite.....	9	0.450	16.1	6.4	4.0	6.9	35.4	125	29.9	45.7
2-B	1¼	Poorly Blasted Granite.....	7	0.793	18.4	5.5	3.9	7.2	36.9	122	48.1	77.5
3-A	1¼	Well Blasted Tough Granite.....	14	0.627	9.6	7.6	1.7	8.2	27.1	133	69.2	83.2
3-B	1½	Well Blasted Granite and Earth..	12	0.659	7.1	5.9	1.6	6.1	20.7	103	91.9	114.7
3-C	1½	Well Blasted Granite.....	6	0.903	8.5	8.0	1.6	7.9	26.0	136	98.6	124.9
3-D	1¼	Well Blasted Fairly Soft Granite.	12	0.772	7.9	4.9	1.0	4.7	18.5	111	127.7	160.0
4-A	1½	Common	8	1.12	5.5	3.9	1.4	4.4	15.2	46	238.0	316.0
5-A	1¾	Fairly Well Blasted Sandstone...	21	0.860	8.7	5.7	2.8	5.7	22.9	75	105.1	135.1
5-B	1½	Fairly Well Blasted Sandstone...	14	1.104	9.1	6.1	2.2	6.3	23.7	83	112.8	187.4
5-C	1½	Hardpan and Well B. Sandstone..	10	1.122	9.5	5.5	1.6	5.6	22.2	74	133.0	182.0
5-D	1¼	Hardpan and Well B. Sandstone..	12	0.775	11.1	6.9	2.3	8.1	28.4	101	62.6	98.0
6-A	1¼	Well B. Shale and Sandstone....	15	0.804	7.5	4.1	1.6	4.5	17.6	96	127.0	164.2
6-B	1¼	Well B. Shale and Sandstone....	16	0.885	7.0	3.5	1.3	4.3	16.1	83	151.9	197.9
7-A	1½	Fairly Well B. Dis. Gran. & Com.	16	0.995	11.3	6.9	1.6	7.0	26.7	135	96.7	137.3
7-B	1¼	Fairly Well B. Dis. Gran. & Com.	16	0.761	11.8	7.6	2.2	7.5	29.1	146	70.9	94.2
7-C	1¼	Fairly Well B. Dis. Gran. & Com.	15	0.925	7.4	5.8	1.2	6.0	20.4	126	105.7	158.5
8-A	1.0	Earth and Some Blasted.....	S.H.	0.592	7.4	3.5	1.7	4.0	16.4	66	93.0	129.7
8-B	1½	Sedimentary Rock	S.H.	0.979	8.9	7.4	1.7	5.7	21.0	88	125.9	167.5
9-A	1.0	Earth, Blasted Shale and Schist.	10	0.866	8.0	8.0	3.2	7.1	26.3	105	73.7	118.1
9-B	1¼	Earth, Blasted Shale and Schist.	11	0.729	8.4	6.3	2.8	6.2	23.7	72	73.7	110.4
9-C	1¼	Earth, Blasted Shale and Schist.	11	0.800	8.2	7.6	3.5	7.0	26.3	104	80.9	109.4
10-A	1¼	Well B. Disintegrated Granite...	S.H.	0.808	9.5	6.4	1.2	6.8	23.9	130	87.4	121.7
10-B	2¼	Well B. Disintegrated Granite...	S.H.	1.152	8.8	5.4	1.1	5.6	20.9	105	178.5	260.9
10-C	2¼	Well B. Dis. Granite and Earth..	S.H.	1.512	10.5	6.7	1.3	6.8	26.3	141	156.5	215.0
10-D	2.0	Well B. Dis. Granite and Earth..	14	0.958	9.8	7.0	1.3	7.2	25.3	81	94.2	136.2
11-A	1¼	Overburden—Well B. Granite....	8	0.862	9.9	6.0	1.3	6.7	23.9	104	78.8	130.0
11-B	1.0	Overburden—Well B. Granite....	10	0.651	8.0	5.7	1.7	6.5	21.9	84	70.5	107.0
11-C	1½	Overburden—Well B. Granite....	8	0.926	10.7	5.9	1.6	6.6	24.7	74	81.4	134.2
12-A	1¼	Overburden—Well B. Granite....	7	0.695	11.5	6.0	2.0	6.6	26.1	85	71.4	124.0
12-B	1½	Overburden—Well B. Granite....	8	0.613	16.7	8.6	3.5	9.1	37.9	130	37.0	58.2
12-C	1¼	Overburden—Well B. Granite....	3	0.692	11.8	6.8	1.6	7.3	26.7	129	42.8	93.3
13-A	1¼	Blasted Rock and Gravel.....	..	0.522	8.4	7.7	2.8	8.3	6.8	126	43.5	70.8
13-B	1¼	Blasted Rock and Gravel.....	..	0.707	13.1	7.2	1.9	7.9	30.1	109	58.7	84.5
14-A	1.0	Caliche and Blasted Rock.....	..	0.741	7.8	5.9	0.9	5.7	20.3	165	95.3	131.2
15-A	1¾	Earth—Well Blasted Limestone..	7	0.930	10.5	8.0	4.1	8.2	30.3	117	68.8	108.6
16-A	1¼	Fairly Well B. Dis. Granite.....	13	0.686	12.1	5.8	1.4	7.3	26.6	120	67.5	93.00
16-B	1¼	Fairly Well B. Dis. Granite.....	8	0.741	9.0	5.7	1.4	6.8	21.9	107	77.2	121.5
Avgs.	1.349		..	0.850	9.02	6.95	1.83	6.26	23.03	107.7	93.90	132.85

Total Cubic Yards Excavated During Studies, 1,017,553

LIQUID ASPHALTIC ROAD MATERIALS

Conclusions from Recent Studies by Division of Tests, U. S. Bureau of Public Roads

In the August issue of *Public Roads* there appears a 21-page detailed report by R. H. Lewis, Associate Chemist, and W. O'B. Hillman, Assistant Highway Engineer, on exposure and laboratory tests on liquid asphaltic road materials of slow, medium, and rapid curing types. The opening paragraph and conclusions of this report follow:

In a report recently published by the Bureau of Public Roads on A Study of Some Liquid Asphaltic Materials of the Slow-Curing Type,[1] it was shown that the action of sunlight, heat, and air on these materials when exposed in relatively thin films produced residues with physical and chemical characteristics differing greatly from those of the residues developed in the usual laboratory heat tests. It was also shown that when these materials were mixed with a standard sand, molded into cylinders by the Hubbard-Field method, and subjected to the same exposure conditions as the thin films, they developed stability, or bonding strength that could not be attributed entirely to the loss of volatile matter.

CONCLUSIONS

The results of this investigation substantiate most of the conclusions arrived at in the 1932 investigation, modify two of the conclusions, and indicate some new conclusions. The conclusions substantiated are:

1. Materials of high specific gravity and their residues are, in general, more susceptible to changes in temperature than materials of low specific gravity and their residues.

2. Hardening due to causes other than loss of volatile matter, and changes in inherent characteristics that may be attributed to oxidation, polymerization, and carbonization, occur to the greatest extent upon exposure and least during distillation.

3. The development of a ductile residue either in the asphaltic-residue test, or in the case of cut-back materials, in the distillation test, does not indicate that the material will develop a ductile residue upon exposure.

4. The bonding strength of the original materials and their residues is roughly proportional to their consistencies, but materials having the same consistency as measured by the present tests do not always give the same stability. The reasons for these differences in stability cannot be determined under the present methods of testing.

The following conclusions are somewhat modified from 1932:

5. The relative rates of volatilization of the various materials can be most readily anticipated from the distillation curves. The different classes of material may be differentiated in the loss and asphaltic-residue tests, especially if the time of reduction to 100 penetration is considered. However, sharp distinctions in initial curing properties, that may be of importance in some types of construction, can be determined only from the distillation curves.

6. Carbonization generally occurs in materials that originally contain some material insoluble in carbon disulphide and carbon tetrachloride, but some materials with exceptionally high solubility in these solvents show a tendency to carbonize under both laboratory and exposure conditions.

The following conclusions are developed upon the basis of the data collected in 1933 only:

7. The Oliensis test is more sensitive than the microscopic test in the detection of materials that have been subjected to excessive high temperatures in manufacture. However, neither test seems definitely to distinguish products that will weather badly.

8. The use of Vita glass in place of plate glass for the cover of the exposure boxes did not materially change the results. However, because of the lateness in the year when these tests were started the results are considered inconclusive.

9. If like periods of the year are used for exposure, satisfactory check tests can be obtained with the exposure assembly used in these investigations.

Many of the laboratory heat tests have been criticized as producing conditions dissimilar to and more severe than service conditions. These investigations have shown that the physical and chemical characteristics generally believed to belong to unsatisfactory materials are developed upon exposure in many products that satisfactorily withstand laboratory testing. While it is possible, by the utilization of identification tests, to restrict materials to a limited number of sources or manufacturing processes, it is impossible to predict, with any degree of accuracy, the weather-resisting properties of the material thus obtained. It is believed that efforts should be directed to the modification of some of the present laboratory heat tests so that differences in the tendency of various materials to develop unsatisfactory residues may be recognized.

[1] R. H. Lewis and W. O'B. Hillman, Public Roads, June 1934, Vol. 15, No. 4.

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Highways and Taxation to Be Studied by Ohio Road Experts

Better roads through the expenditure of less money and a future reduction in the state gasoline tax is in sight in Ohio if the Highway Survey Committee recently appointed by Governor Martin L. Davey to make a study of primary and secondary highways and of taxes is successful in achieving its objectives, as announced in August.

The committee, under the chairmanship of Dr. William E. Wickenden, president of Case School of Applied Science, will gather information on the following subjects over a twelve months' period:

1. Determination of the amount of traffic now carried over the various state trunk highways, over county or secondary roads, and over local or third-class roads. Also determination of the percentage of total traffic carried by the various classes of thoroughfares.

2. Determination of the amount of motor-vehicle revenue paid by rural and urban motorists.

3. Ascertain what are equitable motor taxes and secure equitable distribution of motor tax revenues in relation to needs and use.

4. Ascertain the percentage of total travel carried on city streets and the relationship to revenue paid.

5. Development of a long-time program to eliminate waste, duplication and inefficiency, thereby furnishing the groundwork for an adequate highway system commensurate with present and future requirements.

This program, as well as the information gathered during the study, will provide an unbiased, authoritative guide for legislative highway policies in the future.

▼

A survey of motor travel in Missouri revealed that 24 per cent of all motor tourists stop at tourist camps, 28 per cent spend the night in private homes, and 30 per cent stop at hotels.

ORIGIN AND ROAD BUILDING PROPERTIES OF LIME ROCK

By D. G. RUNNER

Assistant Materials Engineer, U. S. Bureau of Public Roads

FOR A number of years some of the states in the southeastern part of the United States, chiefly Florida and Georgia, have been utilizing one of their natural resources in the construction of highways. This material is limestone, or "lime rock" as it is known locally. Deposits containing this limestone are found over widespread areas in these two states. Owing to the fact that practically all of Florida is within the confines of the coastal plain region, and that the greatest elevation of the state is not over 300 or 400 ft., these limestone outcrops are somewhat restricted in thickness. In Georgia, the elevation in the coastal plain section is somewhat below 700 ft., so that similarly the maximum amount of limestone exposed is also somewhat limited. Due to the attention which has been focused upon the "lime rock" roads of Florida and Georgia, it was thought that a brief discussion of the origin and composition of this material would be of interest to highway engineers.

According to Clarke,[1] 5 per cent of the sedimentary rocks of the earth's crust are approximately 0.25 per cent limestone. Although the percentage of limestone seems to be comparatively small, the varieties are well diversified. The following list giving some of the more

Fig. 1—Lime Rock Road in Florida.

common types applicable to Florida and Georgia, are based chiefly upon physical characteristics.

Semi-crystalline limestones—are usually hard, compact, were once soft and dense, but later were recrystallized into the harder state. This condition is found in most all of the limestone formations of Florida, especially those exposed to weathering action. This type of material is not extensively found in the coastal plain of Georgia although it does occur along certain portions of Flint River.

Fossiliferous limestones—are those which contain the remains of animals in such forms as teeth, bones, shells either as fragments or as whole shells. This type of limestone is found in the Jackson beds of Georgia near Flint River, and in nearly all the limestone beds of Florida.

Shell limestones—are composed essentially of shell fragments bound together with calcareous cement. The classic example of this type of material is the coquina limestone found in eastern Florida.

Oolitic limestone—is composed essentially of concretions of calcium carbonate, very minute and resembling fish roe. This type of material is found along the southern border of Georgia and the southeastern part of Florida, and is exemplified in the Miami oolite.

The Origin of Lime Rock

Calcium oxide (CaO), chemically pure lime, occurs widely in the rocks of the earth's surface. In addition, it is always found in combination with other substances chief among which is carbon dioxide (CO_2). The combination forms calcium carbonate ($CaCO_3$), or limestone. The principal source of calcium carbonate is to be found in the decomposition of the rocks, mainly igneous, at the surface of the earth. This condition is brought about by rain water heavily charged with carbon dioxide. This in turn produces calcium carbonate which passes into solution in ground water, and into surface streams, eventually reaching the oceans where it is precipitated by various means. Under certain conditions the calcium carbonate may take the solid state and be directly precipitated in the form of calcareous ooze. This condition is found to hold where there is a maximum amount of the carbonate in solution, and it is likely that such was the case in the formation of some of the limestone beds along the coastal plains of Georgia and Florida. Another process by which limestone beds are formed may be traced to the activity of marine organisms. These animals absorbed the calcium carbonate from solution to form the skeletal, or hard, parts of their bodies. As these organisms, such as foraminifera, corals, etc., died their shells and other hard parts consisting of almost pure lime carbonate, were deposited on the ocean floors thus starting the formation of limestone beds. Subsequent addition of lime filling the pores and voids of these deposited remains, caused the unconsolidated mass to be further cemented. Table I shows the essential constituents of several kinds of marine invertebrates which played a part in the formation of limestone. According to Clarke and Wheeler,[2] the most important base in nearly all marine shells or skeletons, whether vertebrate or invertebrate, is lime. Molluscan shells, the corals, millepores, some brachiopods, and barnacles are composed almost entirely of lime carbonate.

Furthermore, it has been found that even a small increase in temperature of the sea water will tend to free carbon dioxide from the calcium bicarbonate solution thus resulting in the direct precipitation of the lime carbonate. The warm surface layers of the seas

[1]Data of Geochemistry, F. W. Clarke, Bulletin 770, United States Geological Survey, 1924.

[2]The Inorganic Constituents of Marine Invertebrates, F. W. Clarke & W. C. Wheeler, Professional Paper 124, United States Geological Survey, 1922.

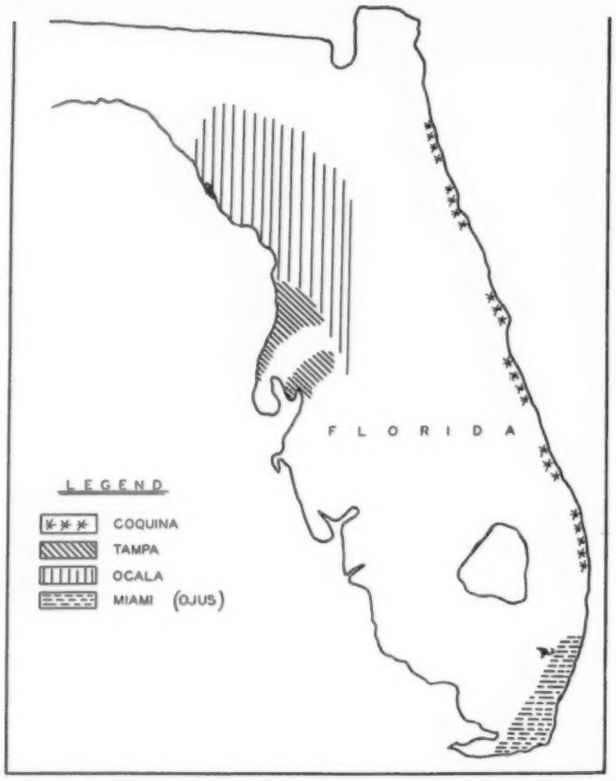

Fig. 2—Distribution of Workable Lime Rock Deposits in Florida. (Based on "A Preliminary Report on the Limestones and Marls of Florida," by Stuart Mossom.)

are saturated with carbonates and are subject to precipitation by any rise in temperature. The formulas illustrative of the chemical action during the formation of limestone is shown below:

Water H_2O	+	Carbon dioxide CO_2	=	Carbonic acid H_2CO_3
Carbonic acid H_2CO_3	+	Calcium carbonate $CaCO_3$	=	Calcium bicarbonate $CaH_2C_2O_6$

Calcium bicarbonate $CaH_2C_2O_6$	=	Calcium carbonate $CaCO_3$	+	Water H_2O	+	Carbon dioxide CO_2

Texture of Lime Rock

Texture[3] applies to the arrangement, shape, and size of the particles of rock. A limestone is composed of grains of calcium carbonate, and depending upon the size of these, may be either fine, medium, or coarse grained. If the grains are microscopic the rock is said to be "dense," and on the other hand if the grains are visible to the unaided eye the rock is "granular." If the particles are cemented by calcite, the texture may be considered as "crystalline," and if the rock has no form or degree of crystallinity it is "amorphous." It sometimes happens that more than one kind of texture may be found in one rock, and as has been pointed out the more characteristics that a given sample has, the better it can be described.

Principal Road Building Lime Rocks

Miami Oolite (*Ojus rock*).—The Miami oolite, or ojus rock as it is sometimes called, outcrops near Miami in Dade County, and in a portion of Broward County.[4] The formation lies almost flat with a gentle dip to the west or northwest. The exposed thickness of this formation varies greatly, with about 10 feet of exposure in the Naranja pit, and about 30 ft. in the Ojus pit. The typical rock is seen in the quarries near Miami is a soft, pure white oolitic limestone containing about 95 per cent calcium carbonate. In many places lenses or pockets of white sand are found. This is especially true in the vicinity of Ojus where the rock has been subjected to weathering and has been altered to a hard rock mixed with white sand. Most of the sand here is in a free state but a large portion has been mixed into semi-crystalline rock. This material hardens upon exposure to the air and rain, and makes excellent road material. The exposed Miami oolite extends in a narrow strip along the southeastern portion of Florida.

Coquina (*shell limestone*).—According to Brodie[5] this type of limestone consists essentially of a mass of shells and/or broken fragments of shells bound by a calcareous cement. The shells originally accumulated on the beaches where they were exposed to wave and tide action, which washed the sand away leaving comparatively clean shell fragments. At a later date the land was elevated and acidulated rain water carried lime carbonate to cement the fragments into a solid mass. Coquina is found along the eastern coast of Florida extending from St. Johns County in the northern part to Palm Beach County near the southernmost part of the peninsula.

Ocala Lime Rock[6]—The Ocala limestone is found in the western part of the state in Marion, Sumter, Levy, Citrus and a few more northern counties. This material is a soft, pure cream to white granular limestone. It is uniform in appearance and physical properties, but has slight differences in chemical properties in various locations. Usually it is so soft that a lump may be crumbled in the hand, but masses of harder material occur irregularly both in size and position in the section

[3]Based on "A Preliminary Report on the Limestones and Marls of Florida," by Stuart Mossom, 16th Annual Report, Florida Geological Survey, 1925.
[4]Mossom, op. cit.
[5]Coquina: The Shell-Rock of Florida, by W. M. Brodie, Mining & Scientific Press, vol. 119, No. 6, Aug. 9, 1919.
[6]Mossom, op. cit.

Fig. 3—Map of Georgia Showing Approximate Location of One of Principal Lime Rocks Deposits in Coastal Plain Region. (Based on "A Report on the Limestones and Marls of the Coastal Plain of Georgia," by J. E. Brantly.)

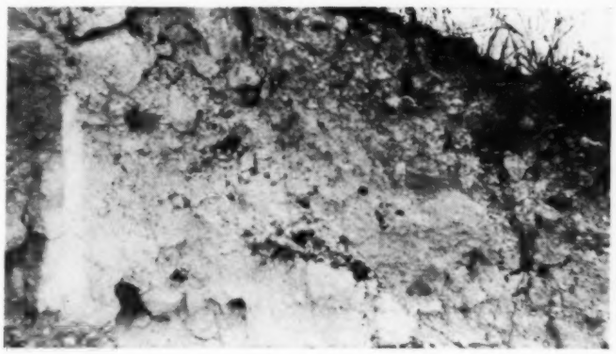

Fig. 4—Outcrop of Lime Rock in Florida

in all pits. In Citrus County this formation attains a thickness of about 115 feet.

Tampa Limestone.[7]—This limestone is found in the western part of Florida, chiefly in Hernando, Pasco, Pinellas, and Hillsborough Counties. In the vicinity of Tampa, the rock is fairly hard, compact and light gray to yellow in color. In Hernando County the rock is semi-crystalline and cream to gray colored. In the northwestern part of this county, the rock outcrops in hard indurated boulders containing flint particles. Another phase of this limestone is a soft amorphous white condition through which is scattered lenses of crystalline limestone.

Table II is given to show the variation in the chemical analyses of the various types of Florida lime rock.

Georgia Lime Rock.—In Georgia, one of the chief lime rock deposits used for road building material, is found in the coastal plain region in the Jackson Group, and crosses the state in a northeasterly direction. It has been found that the Ocala limestone of Florida is essentially of the same age as the limestone of the Jackson Group in Georgia. The outcrops of limestone in the Jackson Group are found in Wilkinson, Twiggs, Bleckley, Pulaski, Houston, Macon, Sumter, Dooly, and in Crisp Counties.

Lime Rock in Road Building

Limestone has been used for a number of years in Florida and Georgia, for base courses or as surfacing material. It has been found that this material makes an excellent foundation course especially when topped with a surface treatment which affords adequate protection to the base course. Lime rock has the peculiar property of "setting up" or hardening when wetted, and as a result this feature is utilized in constructing the roadways. The base courses are usually put down in two layers, with the first course approximately one-half the total thickness of the finished base, or at least thick enough so that the weight of the equipment will not damage the subgrade. The finished half of the base course is watered, rolled and bladed prior to placing the second course. This is done to insure proper bonding of the two layers. In constructing the single course base, the same procedure is usually followed with the exception that enough material is placed on the subgrade so that when compacted it will be of the required thickness.

In order to show how lime rock is used in road construction, excerpts from the standard specifications of Florida and Georgia are given below. In presenting these specifications, only the essential features will be given, due to limited space.

Florida Specifications.—The following specifications for Ocala Lime Rock Base Course and Miami Oolite Lime Rock Base Course are taken from Florida Standard Specifications for Road and Bridge Construction, 1934.

Ocala Lime Rock Base Course (Double Course)
Description

This item shall consist of a foundation course for the surface course or pavement. It shall be composed of Ocala Lime Rock and shall be costructed on the prepared subgrade, in two courses, in accordance with these specifications and in conformity with the lines, grades, compacted thickness and typical cross sections shown on the plans or as directed by the engineer.

Materials

Ocala Lime Rock—The rock to be used shall be of the Ocala formation, and shall comply with the following requirements. It shall show no tendency to air slake or undergo chemical change under exposure to weather. It shall contain, by weight, not less than 97 per cent of carbonates of calcium and magnesium and the remaining 3 per cent must be practically free from organic matter. It shall be uniform in quality and shall not contain hard or flinty pieces in sufficient quantity to prevent securing a smooth surface free from pits and pockets.

Gradation of Lime Rock—The crushed lime rocks shall meet the following grading requirements:

Passing 3½ inch round screen, not less than.....97%
Passing ¾ inch round screen, not more than.....70%

All fine material shall consist entirely of dust fracture.

[7]Mossom, op. cit.

Fig. 5—View of Lime Rock Quarry in Hernando County, Florida.

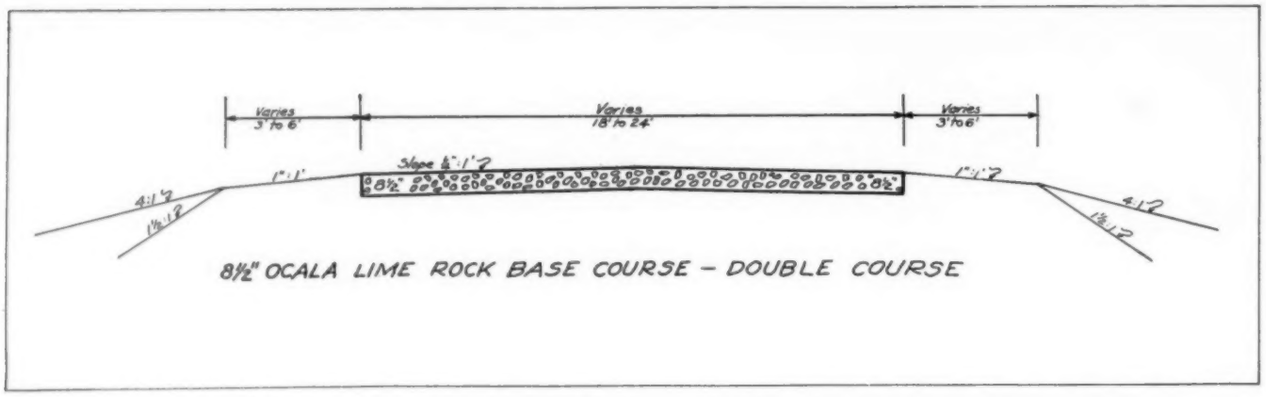

Fig. 6—Typical Cross Section for Lime Rock Base Course. (Courtesy State Road Department of Florida.)

Construction Methods

Equipment—All equipment necessary for the proper construction of this item shall be on the project, in first-class working condition, and shall have been approved by the engineer before construction will be permitted to begin. Rollers shall be of the 3-wheeled power type weighing not less than 10 tons, and shall have a rear wheel compression of not less than 350 pounds per lineal inch of tire width. The rolling capacity of one roller shall be not more than 60 square yards of completed base course per hour of continuous operation, and if the contractor spreads rock in excess of this rate additional rollers shall be furnished in proportion. Road machines shall weigh not less than 3 tons and shall have a wheel base not less than 15 feet and a blade not less than 10 feet. Road machines shall not be pulled with rollers.

Provisions shall be made by the contractors for furnishing water at the site of the work at the minimum rate of 60 gallons per minute measured at the nozzle.

Forms—Unless otherwise specified, form boards shall be provided by the contractor. They shall be of at least 2-inch lumber, square edged and sound, and of sufficient width to extend from top to bottom of loose spread rock. They shall be set true to line and grade, substantially staked in place to insure stability during spreading and rolling operations.

Transporting Rock—The rock shall be transported to the point where it is to be used, over rock previously placed, and dumped on the end of the preceding spread. It shall then be spread uniformly with shovels or forks or with vehicles especially constructed for this purpose. In no case shall rock be dumped directly on the subgrade. Transporting over the subgrade will not be permitted except with the written consent of the engineer, in which case the subgrade must be protected by planking for a distance of at least 150 feet from the point where the rock is being dumped

Spreading Rock—The rock shall be spread in two courses, the first course to be in depth approximately one-half the total thickness of the finished base, or enough additional to bear the weight of the construction equipment without disturbing the subgrade. During the dumping and spreading operations the rock shall be thoroughly saturated with water as required by the engineer.

The first course shall be thoroughly watered and rolled, also bladed if necessary to secure a uniform surface, immediately prior to the spreading of the second course. At no time shall more than one day's work of the first course be spread ahead of the spreading of the second course. All segregated areas of fine or coarse rock shall be removed and replaced with well graded rock to the satisfaction of the engineer.

Compacting Rock—Following the spreading of the second course, rolling shall be continued, adding water as required, until the entire depth of base is compacted into a dense, unyielding mass. Rolling shall be lapped back over the previous day's spread, it being the intention of these specifications that the rock shall again be thoroughly rolled the day after spreading.

Finishing the Base—After the watering and rolling of the second course, the entire surface shall be thoroughly scarified to a depth of not less than 4 inches and shaped to exact crown and cross section with a road machine, then rewatered and again thoroughly rolled. Rolling shall continue until the entire depth of base is bonded and compacted into a dense, unyielding surface, true to grade and cross section.

The above described finishing shall be done at approximately the same rate as the laying and shall generally follow not more than four days behind the laying unless otherwise directed.

If at any time the subgrade material becomes churned up and mixed with the base course material, the contractor shall, without additional compensation, dig out and remove the mixture, reshape and compact the subgrade, replace the materials removed with clean rock, which shall be watered and rolled until satisfactorily compacted.

Miami Oolite Lime Rock Base Course (Double Course)

Description

This item shall consist of a foundation course for the surface course or pavement. It shall be composed of Miami Oolite Lime Rock and shall be constructed on the prepared subgrade in two courses in accordance with these specifications and in conformity with the lines, grades, compacted thickness, and typical cross section shown on the plans, or as directed by the engineer.

Materials

Miami Oolite Lime Rock—The rock to be used shall be of the Miami Oolite Lime Rock formation as found on the lower southeast coast of Florida and shall meet the following requirements: It shall be obtained from pits from which all overburden has

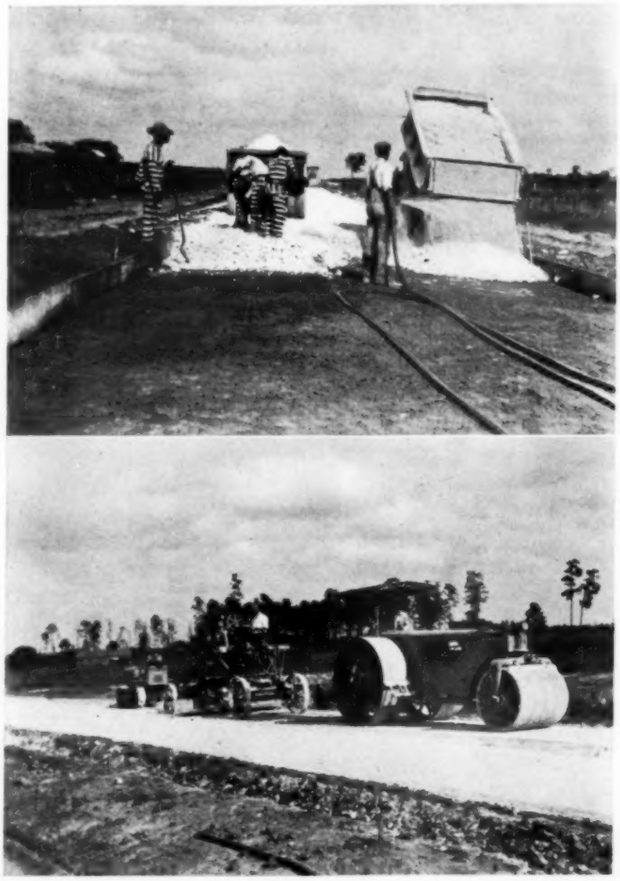

Fig. 7—(Upper) Spreading Lime Rock on Subgrade. (Lower) Shaping and Compacting Lime Rock Base Course. (Courtesy State Road Department of Florida.)

been removed previous to blasting and shall show no tendency to air slake or undergo any chemical change under exposure to weather. As delivered it shall not contain more than 3 per cent of roots, leaf mold or other organic matter. It shall meet the following chemical requirements:

Grade 1: This material shall contain not less than 90% of carbonates of calcium and magnesium nor more than 2% of oxides of iron and aluminum and the remainder must be silica.

Grade 2: This material shall contain not less than 70% of carbonates of calcium and magnesium nor more than 2% of oxides of iron and aluminum and the remainder must be silica.

Gradation of Lime Rock—The crushed lime rock shall meet the following grading requirements:

Passing 3½ inch round screen, not less than..... 97%
Passing ¾ inch round screen, not more than..... 70%

All fine material shall consist entirely of dust fracture.

Construction Methods

The provisions covering the construction methods for Ocala Lime Rock Base Course (Double Course) shall govern the method of construction for Miami Oolite Lime Rock Base Course (Double Course).

Fig. 8—Watering and Rolling Lime Rock Base, Brantley County. (Courtesy State Highway Board of Georgia.)

Georgia Specifications.—The specifications employed by Georgia in the construction of their lime rock base course is essentially the same as those used by Florida. For this reason the specifications for the lime rock material only will be given. These are taken from the Georgia State Highway Department Standard Specifications for Construction of Roads and Bridges, 1933.

Lime Rock

Description—This rock is intended to include all natural lime rock found in Georgia and Florida, provided that in each particular case the material to be used shall comply with the following requirements:

Georgia Lime Rock—The material shall contain by weight not less than eighty (80) per cent of carbonates of calcium and magnesium, the remaining twenty (20) per cent shall be free from clay, organic matter or any other deleterious matter. It shall have a cementing value of not less than forty-five (45).

Florida Lime Rock—The material shall contain by weight not less than ninety-seven (97) per cent of carbonates of calcium and magnesium and the remaining three (3) per cent must be practically free from clay, organic or other deleterious matter. It shall be uniform in quality, and not contain hard crystallized or flint pieces in sufficient quantity to permit securing a smooth surface free from pits and pockets. It shall have a cementing value of not less than forty-five (45).

TABLE I—CHEMICAL ANALYSES OF MARINE INVERTEBRATES SHOWING ESSENTIAL CONSTITUENTS

(All analyses from "The Inorganic Constituents of Marine Invertebrates," by F. W. Clarke and W. C. Wheeler, Professional Paper 124, United States Geological Survey, 1922.)

	A	B	C	D	E
SiO_2	0.14	0.11	0.28	0.23	0.40
CaO	44.84	48.79	53.69	52.50	47.08
$(Al, Fe)_2O_3$	0.36	0.09	0.12	0.10	0.31
MgO	5.23	4.64	0.18	0.43	4.56

A—Sea urchin, British West Indies.
B—Foraminifera, Key West, Fla.
C—Coral, Tortugas, Fla.
D—Hydroid, Tortugas, Fla.
E—Crinoid, Gulf of Mexico.

TABLE II—CHEMICAL ANALYSES OF FLORIDA LIMEROCK

(All analyses from "A Preliminary Report on the Limestones and Marls of Florida," by Stuart Mossom, 16th Annual Report, Florida Geological Survey, 1925.)

Mark	A	B	C	D
Type	Ocala	Miami	Coquina	Tampa
County	Citrus	Dade	Volusia	Hernando
SiO_2	1.30	28.66	17.58	6.54
$CaCO_3$	98.19	70.98	80.00	91.09
Fe + Al	....	....	0.56	1.44
$MgCO_3$	0.55	0.30	....	Trace
Undetermined.	....	....	1.86	0.93

A—Average of five analyses.
B—Average of eighteen analyses.
C—One sample represented.
D—One sample represented.

Grading—The rock shall be crushed so that ninety-five (95) per cent will pass a three and one-half (3½) inch screen, and not more than seventy (70) per cent shall pass a three-quarter (¾) inch screen. The fine material shall consist entirely of dust fracture.

Conclusion.—The usual tests, for the quality of lime rock, consist of chemical analysis, mechanical analysis, cementing value, and slacking. However, recently some additional tests which have been developed by the Bureau of Public Roads, are liquid limit, shrinkage limit, volumetric change, flucculation factor, plasticity index, and others. It is thought that these newer and more informative tests will enable the highway engineer to better distinguish the different grades of lime rock with correspondingly better construction.

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3. The Geology of Florida, E. A. Smith, American Journal of Science, Vol. 21, 3rd Series, No. 124, 1881.
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(On the uses of lime rock)

6. Lime Rock Base Construction, J. H. Dowling, Florida Highways, Vol. 4, No. 4, April, 1927.
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10. U. S. Public Works Project, NRH 92-A, K. F. Kautz, Florida Public Works, Vol. 12, No. 3, April, 1935.
11. Increasing Use of Limerock in Florida Road Construction,

▼

To Take Over Bridges

Warren Van Dyke, Secretary of Pennsylvania Highways, said recently that the State is assuming maintenance of bridges and rural routes located within boroughs. The last session of the General Assembly authorized the transfer. On January 1, 1936, the State will take over all other bridges on existing State highway and rural routes outside of cities, as well as on new routes to be taken over on that date, whether in boroughs or elsewhere. The legislation relieves the municipalities of the cost of keeping up roads and bridges within their boundaries.

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Lake Champlain Bridge Bill Signed

President Roosevelt has signed a bill granting consent to the states of New York and Vermont to construct a bridge across Lake Champlain between Rouses Point, N. Y., and Alburg, Vt.

Repaving With Rock Asphalt Surface at Covington, Ky.

A PAVING job completed recently by the Codell Construction Co. of Winchester, Ky., on Route U. S. No. 25, in the city of Covington, Ky., involved some interesting features. This section was repaved with an asphaltic binder course and a Kyrock surface course placed on an old concrete roadbed. Traffic was maintained during construction operations.

The job was 0.7 miles in length with an average width of 40 ft. and included one 42 degree curve having 30 ft. extra width and 5½ ft. super-elevation. The average gradient was 4 per cent.

Traffic was maintained by dividing the job into two lanes, diverting traffic over one lane while the paving mix was being spread and rolled in the other. A traffic count made while work was in progress showed that a minimum of 602 vehicles per hour and a maximum of 936 per hour was being handled without delay.

The methods employed were as follows: the old concrete top was primed with cut-back asphalt; then the asphaltic binder course was applied at a temperature of about 250° F., being spread 1½ in. thick and rolled to 1 in. thickness with a 10-ton Hercules 3-wheel roller equipped with the ironer roll. This asphaltic binder course was a plant mix (hot mix) hot laid type, the mixing plant being located about 20 miles from the job site. It was mixed at a temperature of 300° F.

The material for the Kyrock surface course was shipped in by rail to a point about two miles from the job site. While still in the railroad cars it was heated by steam to 210° F. It was likewise laid to a thickness of 1½ in. at 180° F. and compacted to 1 in. finish thickness with the roller noted above.

The spreading of the material was handled by establishing four lanes, splitting up the labor crews so that there were two shovelers and one raker to each lane. On the binder course an additional laborer was designated to level off.

The Hercules ironer roll was used in making the first pass with the roller over the newly laid material. A 275 lb. pressure was used for the initial rolling on the asphaltic binder course. Zero pressure was used on the ironer roll for the first pass over the Kyrock and the pressure increased slightly on the subsequent passages of the roller.

The Kentucky State Highway engineers straightedged more than 1,000 ft. of one days' rolling without finding a single variation from a true plane.

M. G. Ross, Division Engineer; George Lyons, Assistant Division Engineer, and John Moore, Resident Engineer, were in charge for the Kentucky State Highway Department, and J. C. Codell and L. M. Harper supervised for the contractor.

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Indiana's Grade Crossing Toll

Twenty-two motorists on state highways outside cities and towns were killed and forty-six injured in accidents at highways and railroad intersections in the eight-month period ending February 28, 1935, according to a statement on July 23 by James D. Adams, Chairman of the State Highway Commission.

Discussing the importance of the grade separation program which is to be carried out on the state highways with funds given to Indiana by the federal government, Mr. Adams said that 11 per cent of all fatalities on the state highway system in the twelve-month period ending June 30, 1934, were in accidents at railroad intersections. Nearly 3 per cent of the motorists injured on the state highways were involved in accidents at these crossings, he continued.

The ratio of death to accidents at grade crossings in the last fiscal year was considerably higher than for the eight months of the present fiscal year, figures on which have been compiled. In the year ending in June, 1934, thirty-five motorists were killed in forty-eight accidents, while for the eight-month period there were only twenty-two deaths in forty accidents.

The ratio of injuries in this type accident has increased, however, there being forty-nine persons injured in the forty-eight accidents reported for the twelve-month period, and forty-six persons injured in the forty accidents in the eight months.

Finishing Kyrock Wearing Course on Codell Construction Co. Contract at Covington, Ky.

A STEEL DECKED I-BEAM BRIDGE IN OHIO

By JOHN C. BLACK
Field Editor, Roads and Streets

A SMALL BRIDGE erected early this year in Shelby, Ohio, is of interest because of its all-steel superstructure, including battledeck floor; its careful adaptation to local conditions, and the history of predecessor structures.

The bridge carries East Main St. (on State Highway Routes 39 and 96) over Black Fork Creek, a stream with a drainage area of 22.5 square miles, a high water elevation of 1082.00 ft. and normal low water of 1072.37 at this point. Prior to the dredging and straightening of the channel some 20 or more years ago, the Black Fork was a source of troublesome floods.

The clear span of the new bridge is 54 ft. 6 in.; span center to center of bearings 57 ft.; roadway width 36 ft. 0 in. between curbs; south sidewalk 15 ft. 3 in.; north sidewalk 13 ft. 1 in.; width over all 66 ft. 2½ in.; horizontal area 3774 sq. ft. The superstructure rests on the old stone masonry abutments of the plate girder bridge which preceded it, very slight changes in the abutments being necessary for this adaptation. The deck, all deck connections, and a large part of the structural connections are welded.

Construction Requirements

The last sheet of the bidding plans contains the following notes relative to construction:

Proposed Structure is a Steel Beam Bridge with Battledeck Floor Plate and Concrete Sidewalks, 57 ft. span, 36 ft. roadway, 4 deg. .09 ft. R.F. skew, 8½ in. approach slabs 10 ft. long by 36 ft. wide and approach sidewalks.

For Details Not Shown on these drawings, reference shall be made to Std. Drg. AS-33 (Approach Slabs), which is supplemental to these drawings.

Loading: This bridge is designed for H-15-33 loading.

Service Lines: Contractor shall co-operate with the Utility Companies and the Municipal Agency in regard to the gas, water, sewer and electric lines by permitting the installation of their respective service lines on the proposed new structure. Plans showing method of installation shall be submitted by them to the State Highway Department for approval.

Existing Superstructure to become the property of contractor as payment for its removal and shall be removed from the site by him.

Existing Abutments to be removed to elevations shown on plans. Masonry removed, to be used to replace brick in North end of East Abutment, and the surplus masonry to be placed as bank and foundation protection at such places as directed by the Engineer. The remainder to be removed from the site by the contractor. Payment for removal of abutments includes placing of bank and foundation protection and disposal of surplus.

Bars Marked Re- are to replace test specimens cut from as near the ends of the bars as possible. Two 2-ft. 0 in. test specimens should be cut from one bar. Not more than one of the RE-bars may be used as test specimen.

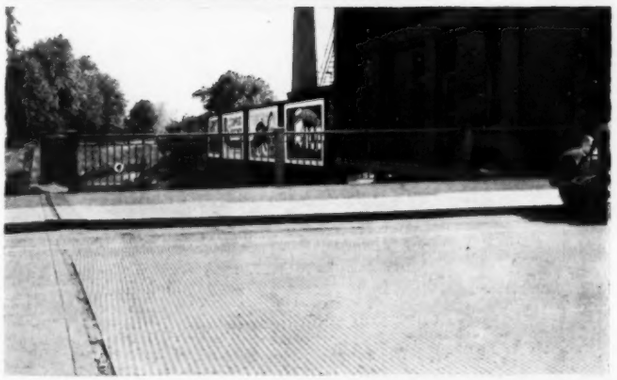
Concrete Mix to be 1:5½ for superstructure and 1:6½ for abutment walls.

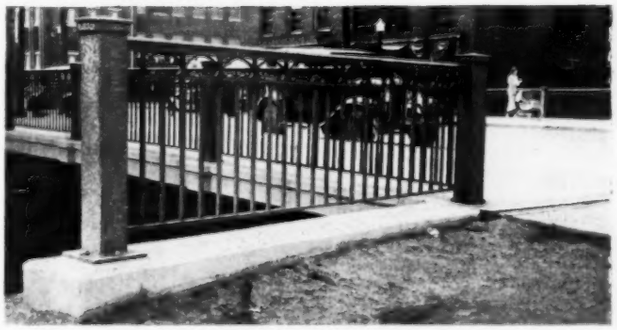
Chamfer all exposed edges ¾ in. unless otherwise shown.

Construction Joints: No horizontal construction joints in substructure other than those indicated will be permitted. Vertical construction joints allowed only by special permission of the Engineer. Concrete sidewalk slabs shall be placed full width of sidewalk between transverse construction joints approved by the Engineer.

Anchor Bolt Holes shall be drilled after structural steel is in place. Special care shall be taken in placing reinforcing steel in bridge seats to avoid interference when drilling holes.

Camber: In order to offset dead load deflection and provide for a finished camber of 1½ in. over the structure the three outermost beams on both sides will have a camber of 2½ in., the remaining beams will have a





Main Street Bridge Over Black Fork Creek, Shelby, Ohio
Upper: View Showing I Beam Construction
Center: Deck Surface and Railing
Lower: Handrail Return at Southeast Corner

camber of 2¼ in. The beams shall be cambered in the rolling mill either while hot or else in the straightening gag after cooling.

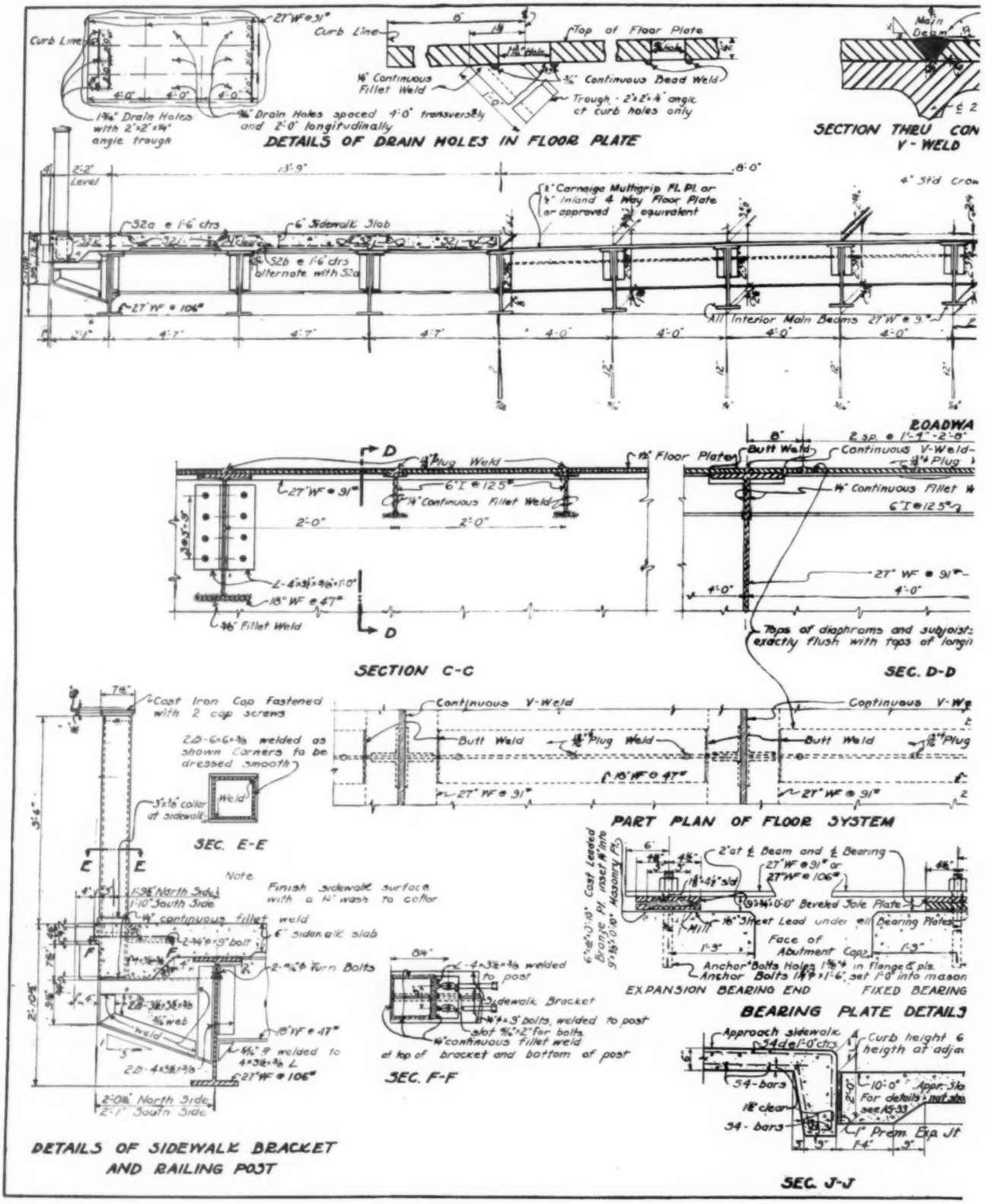
Sheet Lead, Cast Iron Name Plates and anchor bolts included with Structural Steel for payment.

Copper-Bearing Steel shall be used throughout with a copper content of not less than 0.2 per cent. Certified copies of the mill analysis of all copper-bearing steel shall be furnished to the Chief Engineer of Bridges.

Steel Floor Plates shall be ½ in. thick, Carnegie Multigrip, Inland 4-way, or approved equivalent.*

Painting of Structural Steel: The application of the

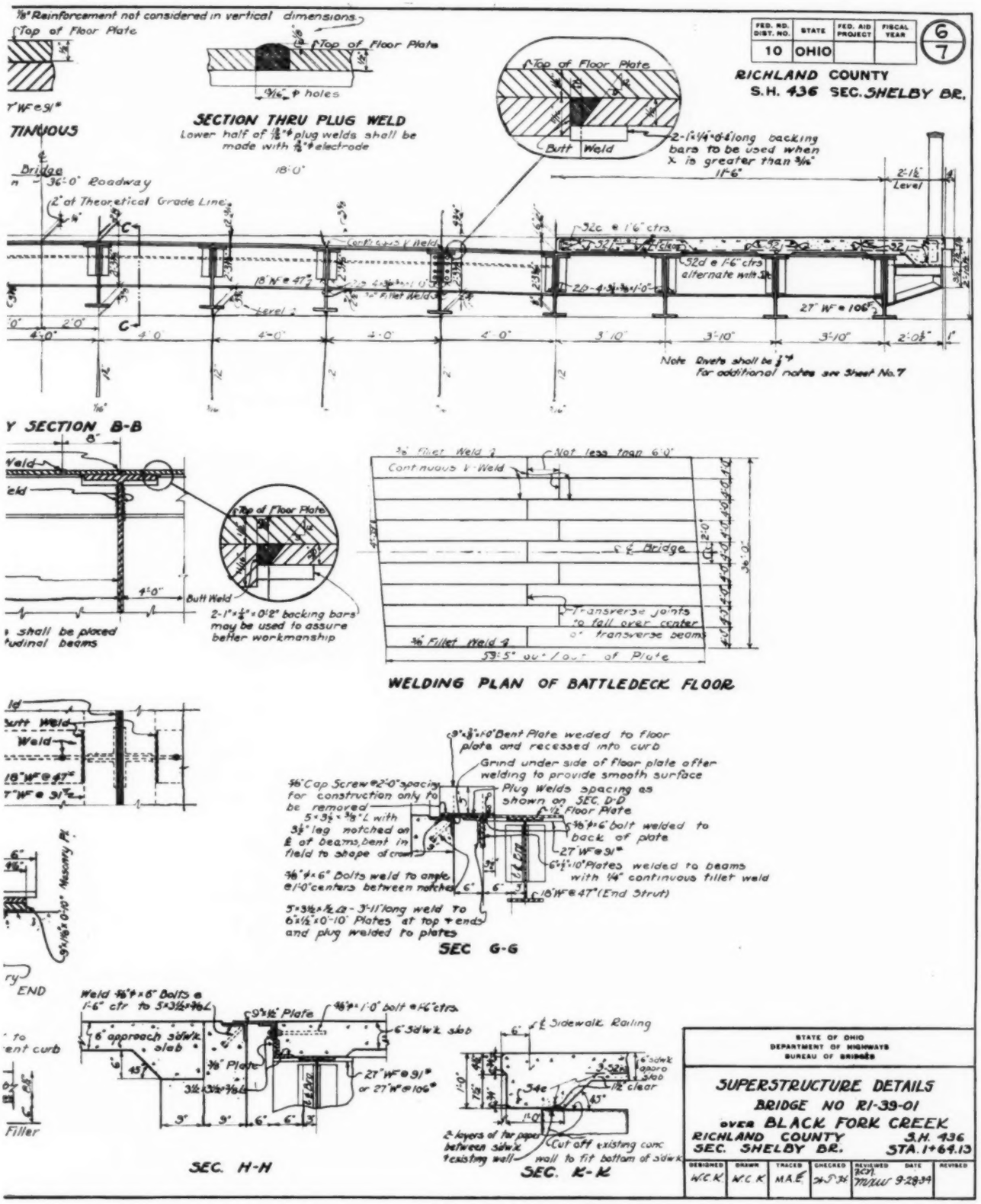
*Alan Wood Super-Diamond floor plates were proposed by the contractor and installed following approval by the Department.



Details of Superstructure

usual shop coat of paint shall be postponed until the structural steel has been erected in the field; except that such surfaces as will be inaccessible after assembling shall be given two coats of shop paint according to Sec. 5-8.04 of the "Construction and Material Specifications." This delayed shop coat and the two field coats shall be applied according to Sec. 5-8.05, except that the top surface of the floor plates shall receive two coats of sublimed blue lead paint in place of the two coats of aluminum paint. The shop painting of inaccessible surfaces shall be considered as a part of the fabrication. All surfaces shall be thoroughly cleaned and rust removed as per Item 5-8.05.

Rivets 7/8 in. round.



Details of Superstructure

Cost and Quantities

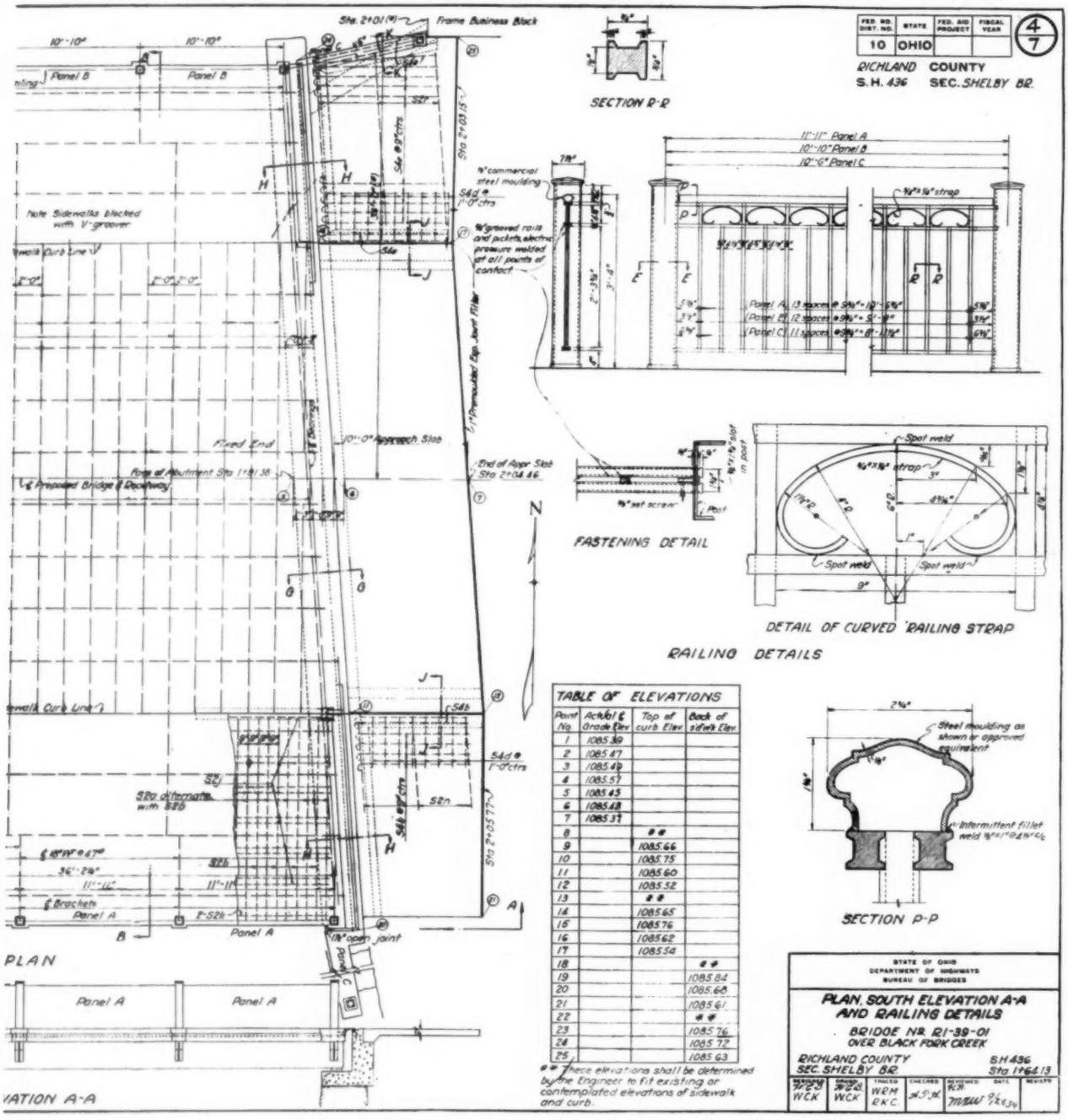
Estimated Cost of Bridge	$13,191.69
Contract Price	13,141.69
Extra Work	199.50
Total Actual Cost	$13,341.19
Cost per square foot horizontal area (superstructure only—old abutments not included)	$3.54

Following are the estimated quantities as given on the plans:

Foundation Excavation, Dry.....20 *Cu. Yds.*
Removal of Existing Pavement and Concrete Base on Approaches.....80 *Sq. Yds.*
Removal of Existing Sidewalks and Curbs on Approaches.....67.5 *Sq. Yds.*
Superstructure Conc. (Sidewalk Slabs), 1:5½ Mix...36 *Cu. Yds.*
Wall Concrete, 1:6½ Mix.....46 *Cu. Yds.*
Reinforcing Steel.....9,030 *Lbs.*
Bridge Railing, Structural Steel (Special).....111.92 *Lin. Ft.*
Structural Steel (except field painting).....178,000 *Lbs.*
Field Painting of Structural Steel (two coats).....178,000 *Lbs.*
1" Premolded Expansion Joint Filler.....130 *Sq. Ft.*
Leaded Bronze Sliding Plates (½" cast).....154 *Lbs.*
8½" Reinforced Concrete Approach Slab, 1:5½ Mix..80 *Sq. Yds.*
Removal of Portions of Existing Masonry.....60 *Cu. Yds.*
Dowel Holes excluding steel dowels, including grouting in place.....137.5 *Lin. Ft.*
6" Concrete Approach Sidewalks, 1:5½ Mix including monolithic curb and bridge seat.....615 *Sq. Ft.*
Removal and Replacement of stone in abutment at the N. E. corner of Bridge and Relaying 24" Sewer with pipe furnished by the City of Shelby....*Lump Sum*
Waterproofing.....744 *Sq. Ft.*

Pleasing Appearance

The only conspicuous feature of the design is the handrail, the artistic character of which appears in the accompanying photographs and details. The entire struc-



Part of Plan and South Elevation—Detail of Handrail

ture—handrail, beams and connections—is painted a pleasing dull green color.

The Builders

The project was financed jointly by Richland County and the State of Ohio. The bridge was designed by and constructed under the supervision of the State Highway Department—John Jaster, Jr., Director; Carl G. Wahl, Asst. Director; J. R. Burkey, Chief Engineer of Bridges, assisted by W. H. Rabe, Chief Designing Engineer, M. X. Wisda, Designing Engineer, and others. Bates and Burge of Mesopotamia, Ohio, were the contractors.

A Tragic History

The first bridge carrying Main St. over the Black Fork naturally was a timber structure. Probably more than one such was built before the steel pony truss which fell on July 4, 1898, resulting in six deaths and more than 100 injuries.

The scheduled high spot of that day's celebration was a wedding on the bridge at 4:30 in the afternoon, the Mayor of Shelby officiating. Twelve hundred people, it was estimated, had crowded onto the floor, which then, as now, measured approximately 60 ft. square. Old timers still recall the many baby buggies in the jam. The top chords of the four trusses were occupied by men and boys who congratulated themselves on their vantage point. Passage across the bridges was completely blocked, and it was not possible for persons in the center of the crowd to work their way out.

The ceremony had just been completed, and bridal party and band were still on the frame platform which had been erected for the purpose in the center, when the bridge dropped without warning a distance of twelve feet to the creek bed below. The floor went down almost intact; all four trusses remained upright, some of those perched upon them remaining there in safety, though others in their confusion jumped down into the struggling mob.

Fortunately the creek was low, but a 12 inch water main was sheared off and poured in a heavy discharge from each end. One boy, caught and held by timbers, was drowned by water from the broken main in spite of heroic efforts at rescue. The bridal couple was uninjured and the Mayor only slightly hurt.

The writer was unable to get positive information as to the character of the failure. Presumably, however, the trusses slid from their bearings after excessive deflection under a load for which they were not designed. All accounts agree that they did not break at their centers. The structure was of light weight, and old at the time of the disaster. It was replaced by a plate girder bridge which remained until the present year, by which time it was so far rusted as to require removal.

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Our Unimproved Roads

Excerpts from an Address, "Highway Legislation and What It Means to Rural Letter Carriers," by Chas. M. Upham, Engineer-Director, American Road Builders' Association, at the 32nd Annual Convention of the National Rural Letter Carriers' Association, Boston, Mass., August 21, 1935.

Information supplied by the National Rural Letter Carriers' Association to our own organization, the American Road Builders' Association, discloses in plain, understandable terms the highway penalties that Rural Letter Carriers still must pay as they traverse their daily routes. A questionnaire sent out by your Association on car operation and driving conditions brought 1,801 replies from 47 states, disclosing the following facts:

The average route traveled was 37.9 miles, of which the average mileage of hard surface was 7.5; the average mileage of improved roads was 12.0; and the average mileage of mud roads was 18.4.

Those 1,801 carriers reported 1,530 unbridged streams. They listed mud as the greatest single obstacle to travel, with the allied obstacles of snow, rutted roads, and bad drainage as close runners-up in causing inconvenience and extra expense.

Bad roads made necessary the use of horses on 17,703 days for these 1,801 carriers, or an average of 32.2 days for each carrier. Prevalence of deep ruts was indicated by reports of more than 50 per cent of the carriers stating that their cars were built too low to operate to the best advantage.

When we multiply the average of these reports by the total number of carriers, we quickly see the enormous cost that you and your fellow Rural Letter Carriers are paying as a direct penalty for unimproved roads.

Using the figures just quoted as a basis, we see that Rural Letter Carriers travel a total of almost 800,000 miles daily on unimproved roads, or "mud roads." Competent authorities estimate that it costs two cents a mile more to operate a car over bad roads than it does over good roads, including depreciation of the car, extra cost of gasoline, etc. Again using simple multiplication, it is plain that Rural Letter Carriers are penalized about $16,000 a day, or $4,800,000 a year, on account of bad roads.

Conditions that prevail for Rural Letter Carriers represent a true cross-section of country road conditions in America. Figures obtained from the most reliable sources show that 42 per cent of the American farms are located on mud roads—the name we apply to unimproved roads.

Of the total 3,040,000 miles of highways in the United States, only 920,000 miles have been improved, and of this only 160,000 miles have been improved with high type surfacing.

Thus, we see that more than 2,000,000 miles of highways remain untouched so far as systematic improvement goes, and a large part of this mileage receives no attention other than make-shift, community work—the kind of hand-shovel and hand-scrape work that was being done by the Pilgrim settlers in Massachusetts 300 years ago.

You carriers, and the drivers of 60,000 school buses that carry 2,000,000 pupils to rural schools, fully realiez the need of road improvement. Farmers and others who use these roads also know the urgent necessity of "getting out of the mud." I am not here to plead for your support of highway improvement. I know you are among the foremost advocates of good roads.

State and Federal highway legislation adopted during the last twenty years has made possible the improvement of primary roads to at least partially meet modern motor traffic demands on these primary roads. What must be done to widen these roads, provide adequate safety features, and otherwise meet the demands of ever-increasing motor traffic is another—but very important—story.

Our concern and your concern of the moment is to see that the auxiliary highway system, variously known as secondary, farm-to-market, or feeder roads, is improved in proportion to what has been done and what is being done for the primary highway system.

SECONDARY ROADS

Principles Governing Selection of Roads to Be Improved with Federal Emergency Funds

Eleven guiding principles for the selection and construction of secondary or feeder roads in rural areas to be improved with funds appropriated by the Emergency Relief Appropriation Act of 1935 were promulgated August 21 by Secretary of Agriculture Henry A. Wallace.

The principles will be sent to State highway departments and the Bureau of Public Roads for their use in planning secondary road projects in the states, District of Columbia, and Hawaii. They were formulated by the Farm Roads Advisory committee appointed by the Secretary.

Availability of employable skilled relief workers, possibilities of project creating economic and social values in areas served, and present and potential traffic are among factors recommended by the Secretary for initial consideration in the rural roads program.

Not less than $50,000,000 of the $200,000,000 highway fund allotted from the funds provided by the Emergency Relief Appropriation Act of 1935 is to be applied to secondary roads. The highway fund was apportioned among the states, District of Columbia, and Hawaii by the Secretary on June 4, 1935. Secondary or feeder roads are defined as rural roads not included in the Federal-aid or State Highway system in the states which have not taken responsibility for county or township roads. In states which have taken such responsibility former county and township roads are considered secondary roads.

State highway officials are authorized to prepare programs of secondary road construction, which are first examined by the district engineer of the Bureau of Public Roads. After he approves they are then submitted by the State highway department to the State director of the National Emergency Council and the State Administrator of the Works Progress Administration. Upon receiving the approval of these two officials, the programs are then returned to the district engineer of the Bureau of Public Roads, who forwards them to the Washington, D. C., headquarters office of the Bureau for final action.

The principles are intended to promote an economical and judicious use of the funds provided for the building of secondary roads. Improvement of such roads—a long felt need—will enable the farmer to travel to his markets, churches, schools, and community gathering places with greater convenience and in less time than ordinarily required. In many areas the feeder roads will serve as direct links to important State and Federal highways.

Dr. A. G. Black, chief of the Bureau of Agricultural Economics, is chairman of the Farm Roads Advisory Committee. Other members are H. S Fairbank of the Bureau of Public Roads, Roy Hendrickson of the Land Policy Committee, Perry A. Fellows, chief engineer of the Works Progress Administration, Willard E. Herring of the Rural Electrification Administration, Hugo F. Kuehne of the Rural Resettlement Administration, and Harlee Branch, second assistant postmaster general.

The complete set of principles promulgated by the Secretary are:

1. Availability in any area of employable relief workers of appropriate skills shall be the primary consideration precedent to allotment of funds for construction of secondary or feeder roads in the area.

2. In the selection of projects consideration shall be given to possibilities of creating economic and social values in areas served by proposed improvements.

Note: It is as important to consider the values that may result by denying improvements and so encouraging abandonment of unproductive and physically handicapped areas as to consider the positive values resulting from improvements in desirable areas. In this connection consideration should be given to available information in regard to:

a) The location of submarginal agricultural land. In the absence of strong local reasons projects proposed for construction of secondary or feeder roads in submarginal areas should be denied.
b) The location of Federal Resettlement projects and other predictable developments likely to increase density of land settlement.

3. Subject to the foregoing considerations preference should be given to roads that connect farms and rural homes with railroad and water loading points, schools, churches, and other points of public congregation, including community developments and unincorporated villages.

4. In the absence of compelling reasons to the contrary, sections of secondary or feeder road proposed for improvement shall connect with previously improved highway system, and preference shall be given to projects that connect with the improved system at two ends.

5. No proposed improvement shall be approved unless a definite need for such improvement can be demonstrated. Need of improvement will be indicated by the existence of either or both of the following conditions:

a) Impediment or hazard to travel at any season.
b) Excessive maintenance cost of the road in its present state.

6. Selection between roads found to be in need of improvement shall be made upon consideration of the relative importance and amount of their potential traffic. The character of traffic shall be considered as well as its density, and the aim shall be to promote the improvement of those roads that to the greatest extent facilitate transportation of farm products to markets and mills and extend to rural areas the benefits of urban development.

7. Selection between roads of similar usefulness in respect to the character of their traffic shall be made on the basis of their estimated potential traffic. In the absence of specific reason to the contrary potential traffic order shall be assumed to be the same as the order of present daily (24 hour) traffic density.

Note: In application of this principle it should be required that all proposals for the improvement of secondary or feeder roads shall be accompanied by a certified estimate of present average daily (24 hour) traffic density on each section of road included, based on actual short counts.

As nearly as possible upon the basis of traffic information available or quickly obtainable it shall be the object to provide for the improvement of secondary or feeder roads in any county in the following order:

1. All roads serving traffic in excess of 100 vehicles daily.
2. All roads serving traffic of densities between 100 and 50 vehicles daily.
3. Roads serving less than 50 vehicles daily.

8. No project shall be approved unless it be determined that the work proposed to be done will result in

a substantial improvement of the roadway. Work properly classifiable as maintenance will not be approved.

9. Improvements made with relief funds shall be capable of maintenance under the existing and estimated potential traffic at reasonable cost.

10. Authorities legally charged with the administration of secondary or feeder roads selected for improvement shall be required, by specific agreement, to maintain roads after improvement.

11. Improvements of secondary or feeder roads made under the administration of county or other local highway officials shall conform to standards established for improvement of roads of like class, traffic density, and other conditions, by the respective State highway departments with the approval of the U. S. Bureau of Public Roads. It is not contemplated under this direction that the high standards of construction ordinarily established for trunk-line and State highways shall be carried over into work on secondary or feeder roads, but it is anticipated that the work done shall result in material betterment of the existing condition.

▼

Parking Control by Meters in Oklahoma City

An interesting experiment in the handling of parking congestion was undertaken by Oklahoma City on July 16, when it marked some 4,000 ft. of curb into 20 ft. parking spaces and installed a meter at each space. While it is perhaps too early to draw positive conclusions, the undertaking so far appears highly successful.

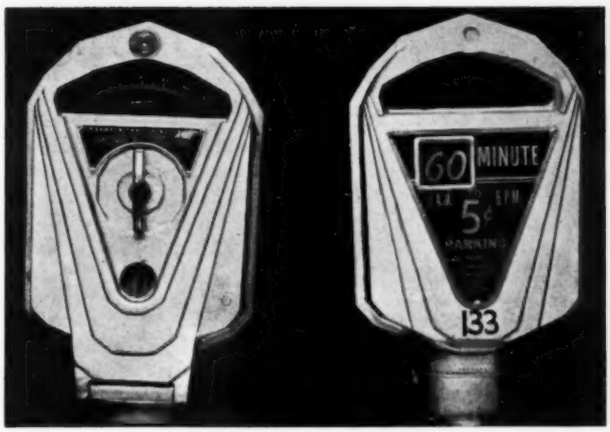
The idea of a meter was not originally conceived as a source of municipal revenue. It was merely intended as a practical means for preventing the abuse of parking privileges—a difficult end to attain in many cities. Later it was decided that a small fee would be desirable—especially as a deterrent to the shifting of cars from one position to another by all-day parkers.

As finally developed by its promoters, Dual Parking Meter Company of Oklahoma City, and installed for trial, the device consisted of a small box mounted at the curb on a pipe standard about 4 ft. high. Five cents is the parking fee. When this is deposited in the box and a handle given a quarter turn, a green signal appears in a window at the top of the box to show that the fee has been paid. At the expiration of the parking period the signal drops indicating thereafter that the car is over-parked. A meter at back of box indicates at any time just how many minutes of parking time remain. Each meter is conspicuously marked with a serial number.

Allowable parking periods in Oklahoma City are kept the same as before meter installation. There are 15 minute, 30 minute, 45 minute and 60 minute areas, and the legal time in each area is shown conspicuously on the meter, but the parking fee is the same (5 cents) in each.

Enforcement of regulations is, of course, the function of the police department. When a car is observed parked without the green sign showing on the meter, the policeman notes its license number and the number of the meter, and reports to the police station. No ticket is left for one full parking period, but the car owner is required to report at the station within 24 hours and pay 25 cents for parking beyond the limit. Failure to report brings a fine.

If a car remains over-parked for a second full period, a police ticket is left, and a 50 cent instead of a 25 cent payment is required. Longer parking involves a fine.



Front and Rear Views of Parking Meter Box

Policing under the new system has been much simplified, and the number of necessary policemen reduced, one officer on a motorcycle having no difficulty in keeping track of the down signals.

A secondary effect of the metering system is to keep cars rigidly within the limits marked on curbs—20 ft. for each car—so making the in-and-out movement easier, with no bumping around and denting of fenders.

It is reported that public reaction to the meters has been very favorable, and that Oklahoma City has now arranged for a second installation larger than the first.

Daily average collections of 45 cents per meter were reported for 174 meters during the first 30 days operation. This would be at a rate of $135 per year of 300 business days—enough to pay for the meters and leave a very handsome profit.

Incidentally there are legal questions, for while Oklahoma City's parking meter ordinance has been sustained by the District Court, it may still have to run the gauntlet of State Supreme Court.

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Names Tunnel Authority

Mayor La Guardia of New York has named three prominent business men to constitute the Queens-Midtown Tunnel Authority, an agency set up by the Legislature this year to construct and operate a toll vehicular tunnel between Thirty-eighth Street, Manhattan, and Borden Avenue, Long Island City. Those appointed by the Mayor to the new authority were Alfred B. Jones, president of the Houston Properties Corporation and former president of the Kelly-Springfield Tire Company; William H. Friedman, president of the Carey Press Corporation, and Albert T. Johnston, retired president of the Borden Milk Company. Mr. Jones was named chairman of the new authority.

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California to Help Its Cities in Illuminating Highways

Governor Merriam of California recently signed the Edwards Bill, authorizing city officials to use a portion of their share of gasoline taxes to help pay the cost of illuminating main arterials embraced within the primary and secondary highway system of California and which pass in or through cities, towns and populous areas.

It is claimed this measure will curb the appalling number of traffic fatalities on dark thoroughfares by providing adequate illumination, and will lower the lighting cost of main boulevard frontage owners approximately 40%, since such property-owners in the Los Angeles metropolitan area are paying in many cases the entire cost.

EDITORIALS

1936 Road Show

Cheerio! There's to be a good, old fashioned road show at Cleveland, Jan. 20 to 24. We'll meet old friends and new machines; and if we don't make new friends our time will be at least half wasted.

The time for the show is ripe. Last year and the year before a pulling in of horns was necessary; possibly some of us have been wholesomely chastened; but this year, with real reason to rejoice, what could be more appropriate than a combined jollification, exchange of ideas, and presentation of babies fresh from the maternity wards of our plants? The older children, too, will be good to look at. Let's go!

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The Winter's Tale

In this issue we have four pages of winter road maintenance pictures. In October we shall have as many more. These pictures show many ways of meeting the snow problem. They stretch from Maine to California and from British Columbia to Washington, D. C. In one of our articles a state engineer gives pointers on the treatment of icy pavements.

The winter season is almost here, and it is time to be making plans. ROADS AND STREETS will welcome accounts of methods which have proved successful. Brother, can you spare an idea?

▼

Room for All—Even the Railroads

Little virility—plain manliness—has marked the recent laments of railroad managements for their loss of business to the highways. Thank God, their actions have been better than their words.

Childish, to say the least, have been the repeated complaints of unfairness and the demand for taxation and other restrictive legislation to curb truck and bus competition. Such a policy, if made general in our national economy, would obviously stop all progress; had it been general in the past the railroads would not now exist. As a matter of fact, there were teaming and water transportation interests in the old days which fought railroads just as inconsistently (and just as ineffectually) as the rails have in later years fought motor transport.

And what was the attitude of the railway magnate toward these protests made 75 or 100 years ago? Or what has been his attitude since then toward persons or developments which have clashed with his ambitions or what he was pleased to consider the interest of his stockholders? Why, it was magnanimous and considerate of course! The captains of railroad industry understood and sympathized with the plight of wagoner and boat owner, and saw to it that they were compensated for the business taken from them by the iron horse. Later, when railroad interest and public interest ran counter, as they sometimes did, the railroads yielded kindly and gracefully. No rail leader thought of charging "what the traffic would bear," and none ever used so vile a phrase as "the public be damned."

Railroad relations one with another were on an equally high plane. They respected each other's rights, and if competition developed it was merely a friendly competition, conducted in gentlemanly fashion without loss to either party. As support from the public treasury, they had huge land grants, but that was for the encouragement of transportation and communication, and was entirely different in principle from the construction of public highways for use without charge. Truly, them was the good old days!

But regardless of such considerations, the railroad stockholder has cause for concern; and we may properly sympathize with him and his corporation in their current difficulties, which are by no means all of the railroads own making. The morals and the acts of a generation gone are not today's responsibility. But the failure to learn the lesson of the past—the inability to apply it to today's problems, where old conditions are reversed—these are faults for which the present suffers, and will suffer till a broader outlook prevails.

The brighter side is this: Long distance haulage of most bulk freight and heavy freight can still be done cheaper by rail than by truck; and so far as can be foreseen, will continue to be done cheaper. Nor need the railroads despair of holding the bulk of long haul business in lighter goods. Only for a very limited amount of special service is it likely that trucks can compete on the great distances. For short hauls the situation is reversed. There it is only for the special classes of business that the rails can hope to hold first place, and the ultimate elimination of a good many branch lines seems inevitable. The sooner this is recognized the better. But taken altogether, there is, and will continue to be, a large freight business for the railroads.

The passenger field is more disturbing, and until recently about all the great captains could do was to slump in their chairs and bemoan their loss. Now, however, a little spinal rigidity is showing, and they have supplied increased speed and comfort which are actually drawing traffic. For example (by no means the only example) it is hardly practical to average 60 miles per hour between Minneapolis and Chicago by auto; but "The Hiawatha" does better than that, and affords vastly more comfort in hot weather, in cold weather, or in storm. The decline in railway passenger travel may even now be ended, though one should not be hasty in jumping at such a conclusion—especially in view of the present extent and future possibilities of air travel.

Improvements have a way of coming in spite of opposition, even opposition from such powerful interests as the railroads. The managements of those great institution are far more sensible in trying to check losses by improving their own service than by attempting to block development of other means of transport.

There is business at present for both railways and highways—not as much for the former as might be wished but at least a substantial amount. With returning prosperity this business should grow; and it is not inconceivable that in time, and perhaps with some change in character, it will become a bigger business than any which the railroads had in the past. Compare the gas companies: the advent of the electric light threatened their existence, but the biggest of their plants in gas light days would be puny beside a modern plant supplying heating, cooking, and industry. The telegraph remains a great institution despite telephone and radio.

If railroad management lacks breadth of mind to see the folly of obstructing progress, that is its misfortune and the misfortune of railroad share holders. Under no circumstances should it be allowed to interfere with highway transportation or development. Such interference, though it could be but temporary, would involve too great a national loss.

NEW EQUIPMENT AND MATERIALS

FWD Develops Portable Rock Crusher Unit

A new portable rock crusher unit has been developed by the Four Wheel Drive Auto Company, Clintonville, Wisc. The new machine consists of a 3-ton FWD truck of the seat-over-motor type equipped with an overhead eccentric type rock crusher, mounted on the rear of the frame and driven by the truck motor. The crusher is equipped with continuous bucket feeding and loading elevators of the belt type. This portable crusher is designed to answer the demands of highway officials and contractors for a machine which can be speedily moved from one road building location to another. It is especially adaptable for use along highways being surfaced.

The rock crusher is driven direct from the main shaft of the transmission. With a governed engine speed of 1200 r.p.m. in direct drive and by means of a four to one reduction in the drive sprockets of the crusher, a crushing speed of 300 r.p.m. can be maintained.

View of FWD Rock Crusher Unit from Loading Side. The Elevators Can Be Used in Loading Trucks

The rated capacity of the unit at this speed ranges from 50 to 125 tons per day, varying in accordance with the hardness and size of the stone and gravel used.

Its short wheelbase gives the truck the maneuverability necessary to the reaching of stone and gravel supplies located in cramped quarters.

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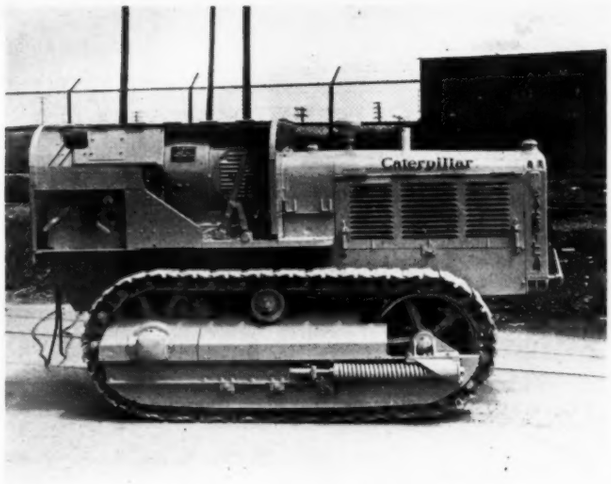
New Welder Unit

A compact electric welding unit designed by Caterpillar Tractor Co. of Peoria, Ill., has been announced as a standard addition to the company's line of products. This unit consists of a General Electric generator and a "Caterpillar" Twenty-Eight Tractor.

Because of its flexibility, short turning and track-type construction, this outfit is able to get into otherwise inaccessible spots along railroad right-of-ways. It can be driven over rails, steep shoulders, and can rest alongside the track, clear of traffic while welding is progressing. Its drawbar is also free for pulling jobs often found unexpectedly along a section during track repair.

From the tractor engine flywheel back, the platform has been redesigned to include an enclosed generator and equipment, with maximum efficiency of the welder unit in mind. The design attains compactness through arrangement of generator and its accessories. The top of the welder section is only a few inches higher than the tractor hood. Controls and seat have been moved to the right, permitting comfortable and convenient tractor operation.

The generator is 300 amperes, 40-volt and of the D.C. type.



New "Caterpillar" Welding Unit

It is operated by power take-off at the rear of the tractor through a V-belt drive. The control panel is handily located on the right rear side of the tractor. Compartments are built at the rear of the unit for reeling and storing welding cable and to keep an ample supply of welding rods. A hinged steel cover and compartment doors fitted with hasps and locks, protect the entire assembly and tractor operating space from pilferage and weather.

▼

New Diesel Starting Batteries

To provide adequate voltage characteristics for starting Diesel engines with the required high cranking speed the Electric Storage Battery Company, Philadelphia, Pa., have developed a new line of batteries particularly designed for high current up to 1,600 amperes at low temperatures.

Considerable study has been given to the construction of these batteries to make them of maximum durability with minimum size and weight conducive to long dependable life. For example, extra heavy flexible lead plated copper connectors are used between cells to eliminate possible breakage from vibration or expansion due to temperature. Likewise heavy duty genuine hard rubber monobloc containers are used to withstand hard usage.

Several types and sizes are available for meeting the requirements of various engine sizes from 25 to 600 HP. where the required voltage varies from 12 to 115 volts and the current from 300 to 1,600 amperes. These batteries are designed and constructed for truck, tractor, bus, and road construction machinery.

Since each type and size of engine represents a different problem it is suggested that advantage be taken of free engineering service of the Electric Storage Battery Co. on the proper selection of a battery.

32 Volt New Exide Diesel Starting Battery

New Type of Dump Body

The accompanying illustration shows an English dumping truck of a type which has been in successful operation for several years, but is only now being introduced in the United States.

The essential principle is a floor built like a belt conveyor, which permits the complete dumping or unloading of the truck without tilting. The very complete control afforded by this device permits the deposit or distribution of loads with the very greatest accuracy, and is further of special convenience on steep grades and hillsides where dumping by tilting bodies is sometimes difficult.

In England this equipment is successfully used in unloading boxed and packaged goods from commercial trucks. It also permits the separation of bulk loads by partitions, thus avoiding contact or mixing in transit.

The mechanism is exceedingly simple, consisting merely of the conveyor belt floor winding on rollers at front and rear, the rollers being provided with cranks for operation by hand. Gears connecting the crank and roller are variable according to the anticipated weight of load. It is stated that in England 10-ton loads are completely unloaded by one man in less than 2 minutes, while loads of 3 or 4 tons can be disposed of in a matter of seconds. However, the American concern handling this project, Easton Car and Construction Co., Easton, Penna., is considering the use of a power take-off, as more in line with American practice.

An English Truck Dumping a Three Ton Load of Sand.

New Power Shovel

The new Manitowoc speed shovel, dragline, and crane, made in 1 to 2 cu. yd. capacities by the Manitowoc Engineering Works, Manitowoc, Wis., is stated to embody many new and improved features in design and operation. Carrying out the original design, which includes the popular gear shift and plunger type precision hoist clutches, and other patented features, care has been taken to provide for greater accessibility and perfect lubrication. Some of the major accomplishments include: all gears and other parts are spline fitted to shafts, there being only one press fit throughout the entire machine. All gears and working parts of the machine are fully enclosed and operating in filtered oil circulated under pressure by means of an oil pump. The single exposed working gear is the large ring gear and swing pinion.

There are only thirteen gears (including the large ring gear), and one worm gear, in the entire machine when silent chain power take-off is used, and this number is increased by two when helical gear drive is desired.

All motor controls are extended to the operator's station, allowing for quick and complete control of the power plant without the operator leaving his station. All machines are equipped with the patented accelerator control giving variable speed to the motor. The patented automatic swing lock is a feature on all speed shovels and cranes, and when the machine is not rotating the rotating bed is automatically locked at any point. A crawler lock that locks both crawlers in either the forward or backward movement is also a special feature. A major improvement is the new style disc swing and reversing clutches.

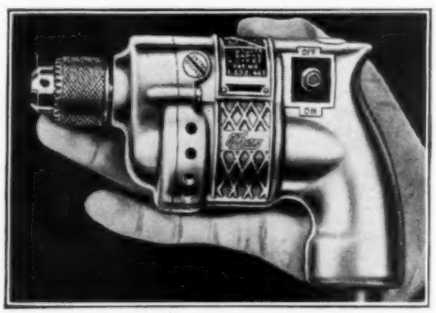
The tubular type shovel and crane booms are a new development and provide for much greater strength with less front end weight. In designing the shovel attachment a new departure from older methods has been adopted. The dipper sticks are mounted on the under side of the shipper shaft sprockets, taking advantage of the normal upward pressure of the dipper sticks when operating under load, thus providing full and proper meshing of the sprocket teeth with the racks. Another improvement is in the power take-off which provides two operating speeds, making it possible when necessary to reduce the speed of any or all operations by 20 per cent below the regular or fast operating speed.

Manitowoc Model 175, 1¼ Cu. Yd.

Thor Announces Smallest Portable Electric Drill

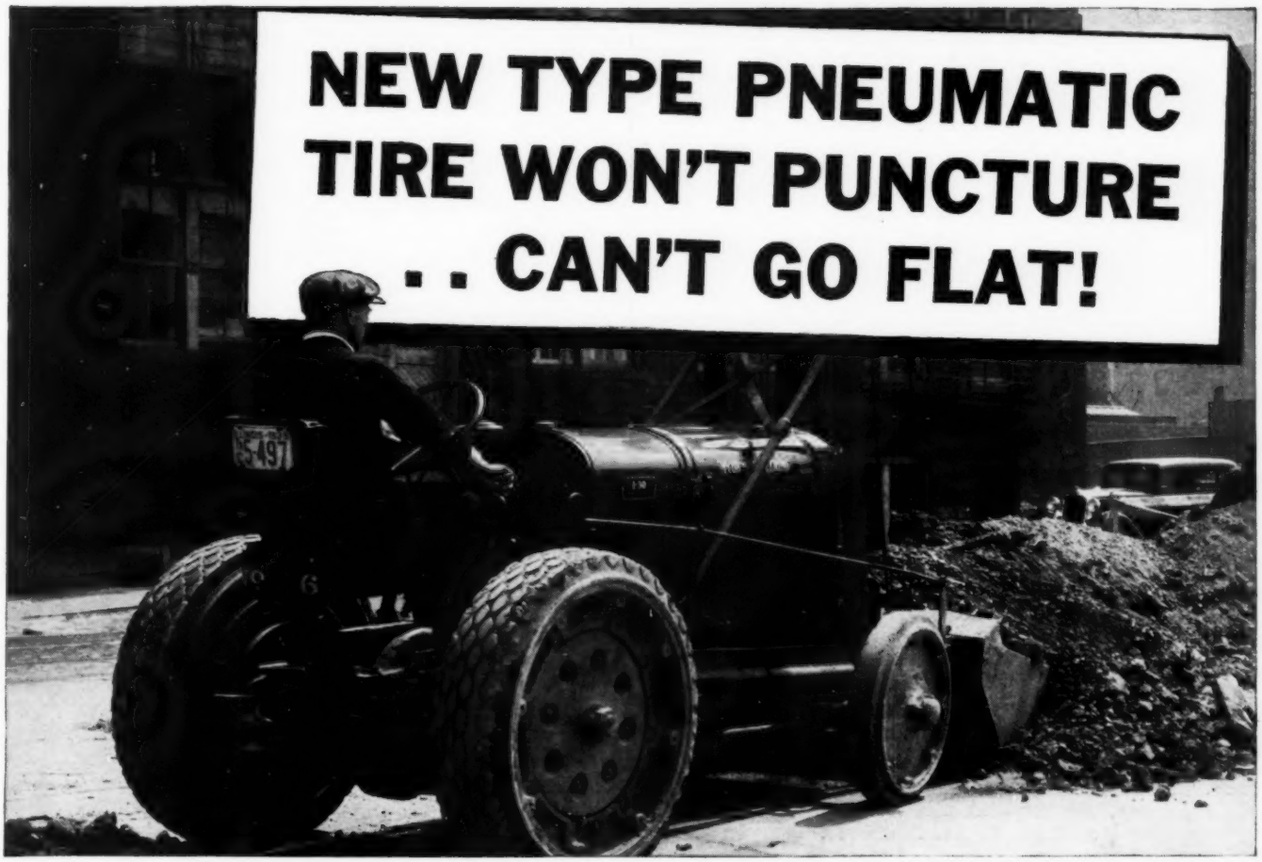
The smallest, lightest weight, portable electric drill ever built, weight 2½ lbs., but with the same power as many larger tools, has just been introduced by the Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago. It is said that this tool, the U-14 in the ¼ in. capacity and the U-13 in the 3/16 in. capacity, will drill through steel ¼ in. thick in 5 seconds. Its perfect one-hand operation makes it a tool that serves equally well in production and plant maintenance.

Highest grade ball bearings and accurately machined, heat-treated helical gears reduce noise and vibration to a minimum and increase motor efficiency. These same features also reduce heat generated, which is extremely important in a tool of a size where the operator's hand covers as much of the tool as in this case.



Two and One Half Pound Electric Drill.

Specifications. U-14 Capacity ¼ in. drilling; Free Speed, R.P.M. 2500; Weight 2½ lbs.; Length overall 6¾ in.; Equipment Jacobs Chuck and 1 Extra Set of Brushes; Spindle Offset 1 in. U-13 Capacity 3/16 in. drilling; Free Speed R.P.M. 3750; Weight 2½ lbs.; Length Overall 6¾ in.; Equipment Jacobs Chuck and 1 Extra Set of Brushes; Spindle Offset 1 in.



CUTS ROAD MACHINERY OPERATING COSTS SAVES TIME . . SLASHES FUEL BILLS

Z-P (Zero Pressure) Pneumatics never go flat — never need the slightest attention. Yet this exclusive Goodrich development is not a solid tire. Every Z-P has a giant air cavity underneath the heavy traction tread. This pocket

of air cushions the load, ends jarring and jouncing. Makes any kind of job easier for men and machines.

As for traction—a Z-P Pneumatic pushes the soil under the tread, packs it down, actually forming its own track as it goes. There's none of the usual sinking or spinning in soft ground or sand. And the tread is self-cleaning!

That's why users report that three maintainers on Z-P Tires do the work formerly done by four. . . .

Why tractor working speeds are increased. Why vibration is lessened and repair bills lowered. Why they save up to 20% on gasoline and fuel.

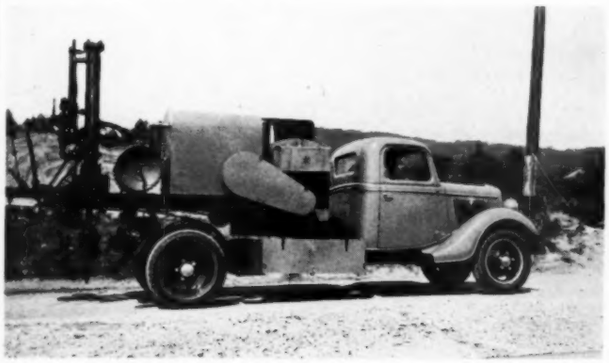
You, too, can get extra service out of tractors, mowers, snow brooms and road machinery with this revolutionary type tire. See your Goodrich truck tire dealer or write for information on changeovers. Address Dept. Z-15, The B. F. Goodrich Co., Akron, Ohio.

Goodrich Z-P ZERO PRESSURE Pneumatic Tires

SPECIFY Z-P PNEUMATICS ON ALL YOUR NEW EQUIPMENT

Concrete Cutting Corporation Introduces New Unit

The Concrete Cutting Corporation of America, of Brooklyn, N. Y., announces a new one-unit utility concrete breaker. The machine consists of a breaker and compressor mounted on a Ford V-8 truck. Air is furnished by a 180 cu. ft. compressor, driven by a 30 h.p. Buda motor. All controls, such as self-starter, throttle lever, clutch lever, swing lever, stop and signal button, are at the operator's finger tips.



Utility Concrete Breaker

This device is compact and weighs 10,400 lb. It cuts a width ranging from 1 in. to 5 ft. 4 in. in one operation. Breaks all kinds of road material and breaks concrete pavement at 100 sq. yd. per hour and trench 2 ft. wide at the rate of 50 lin. ft. per hour, according to statements by the makers.

New Series AP Wico Magnetos

The ignition unit pictured below is described as follows:

Installation. Flange-mounting or S.A.E. standard high or low base mounting.

Weight. 7¾ pounds complete with impulse coupling, dust cover and adapter plate.

Finish. Dulux High Gloss baked-on enamel over priming coat; bright aluminum trim.

Spark Control. Fixed or variable, as desired.

Range of Application. 1, 2, 3, 4, and 6 cylinder engines; 2 and 4 cycle engines.

Coil. Stationary.

Pole Shoes. Laminated and die-cast in main magneto housing.

Circuit. Flux reversal type.

High Tension Distributor. Jump type with monel metal segments in distributor cap and also in distributor rotor.

Impulse Coupling. Furnished as required.

The New Wico Ignition

Ventilation. Finely meshed screen in lower side of distributor cap, with baffle to protect breaker assembly.

Timing. A timing mark and pointer provide for easy timing of the magneto to the engine upon removal of the distributor cap.

The manufacturers, Wico Electric Company, Springfield, Mass., say further of the new magneto:

"Its compact construction and the use of aluminum die-castings have brought about considerable saving in weight, probably from 30 per cent to 50 per cent over magnetos of the convention rotary type. The use of needle bearings and circulating lubrication has made possible higher speeds than have been successfully attained heretofore. It is true, of course, that carefully engineered mechanical design, plus the nearly perfect balance in the electrical circuit, have contributed considerably toward this attainment. The magneto ran continuously for 2185 hours at speed of 6500 r.p.m., without any appreciable wear on any part of the magneto except contact points and breaker bar. The function of each of these, however, is such that there is compensation in the wear on the breaker shoe for that taking place on the movable contact point."

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A New U. S. Air Hose

The Mechanical Goods Division of U. S. Rubber Products, Inc., has announced a brand new type of hose for pneumatic tool and air drill service—the U. S. Super Royal Cord. The outstanding feature of the new hose is its "tire-like" cords laid in tough rubber cushions isolated from adjacent plies to prevent rubbing or shearing. "U. S." claim that this hose can withstand any amount of pulsation, sudden expansion under pressure and constant flexing in use.

This new hose carcass makes the hose so tough, it is said, that it shows remarkable resistance to external blows, bruises and abrasions. This durability is due not only to the internal structure but to the specially compounded brown rubber cover which will stand unusual abuse and will not peel when cut or gouged.

For additional protection against the destructive action of hot oil in the air line, the tube of the U. S. Super Royal Cord is made of the finest oil resistant rubber.

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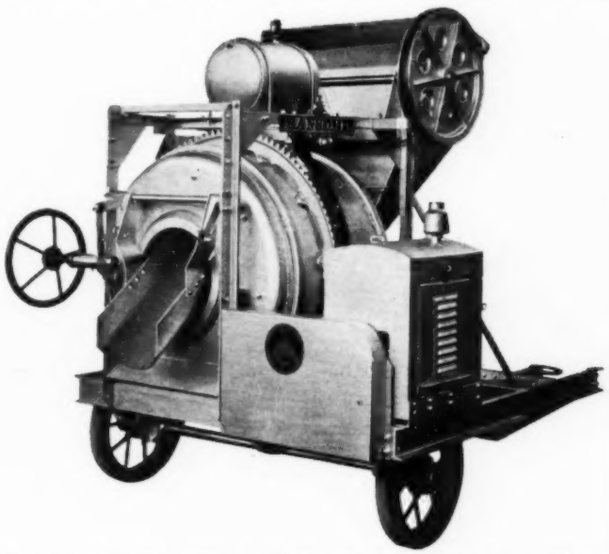
New 7-S and 10-S Mixers

Among the recent developments of Ransome Concrete Machinery Co., Dunellen, N. J., are the two-wheel, trailer type, end discharge concrete mixers in the 7-S and 10-S sizes.

These new trailer type mixers are typically "Ransome" in design, quality and workmanship, the same as the pavers and larger mixers built in various sizes up to 4½ cu. yd. batch capacity.

These trailer type mixers are of light weight but heavy duty construction and are arranged on shock-absorbing springs with steel or rubber tired truck wheels equipped with roller bearings. Mixers are compact and well-balanced for towing and easy



Ransome New Two-Wheel, Trailer Type, End Discharge Mixers

maneuvering on job, permitting mixers to be located in limited spaces.

Other features and refinements in these new mixers are: positive water control with non-by-passing water valve; all steel drum with drum shell and mixing blades of high carbon wear resisting steel; solid steel roller tracks welded to drum and machined to true diameter; discharge chute also of high carbon wear resisting steel; each roller equipped with two Timken tapered bearings; speedy power loader skip of streamline design that elevates to a 50-degree angle, dumping its load into the drum fast and clean without any pounding; countershaft revolving in Hyatt bearings in self-aligning boxes. Operating levers are arranged at one end for easy one-man control.

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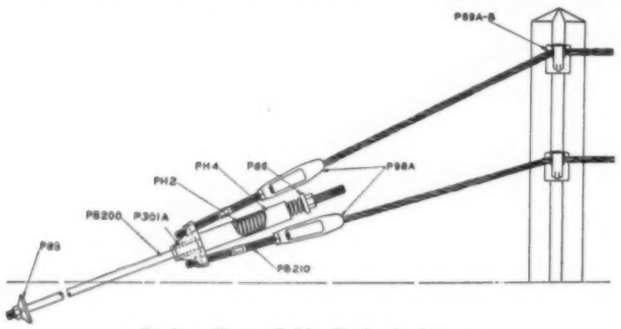
Highway Guard Cable Fittings

A cable splice that provides for making up each cable end separately and then joining them by means of a union nut is a product of the Malleable Iron Fittings Co., Branford, Conn. The splice is used with two conical wedges grooved for the usual three strand ¾ in. highway guard cable. It is stated this construction has been tested to give an ample safety factor over 20,000 lb. cable, rating at least 20 per cent.



Spring Type Cable End Anchorage

The latest spring type cable end anchorage as used in Massachusetts, also a product of the Malleable Iron Fittings Co., is illustrated below. The illustration shows also the anchorage post offsets developed for triangular concrete or steel posts. The patented compensating spring principle eliminates seasonal adjustments for contraction and expansion of the cable due to temperature changes, and automatically keeps the cables taut at all times. This is an important factor in the appearance of the entire cable guard rail set-up, and improves its efficiency as there are no sagging loops in the summer time. The small adjustment reaching between the pipe shield and the retaining washer provides some resiliency under impact on the cables, but as soon as the spring is compressed to the point where this pipe shield and washer meet, then the anchorage functions as if no spring were used. This prevents serious overload and spring breakage.

Another recent product of the above company is a claw-type offset for tubular iron posts. This construction is primarily for small bridges and culverts, etc., where pipe posts with special cable offset fittings may be provided to carry cable runs continuously across such bridge, culvert, etc., from posts of other types on either side without dead end construction on either side. This is said to represent a considerable saving in construction costs, and is particularly applicable to second class highways.

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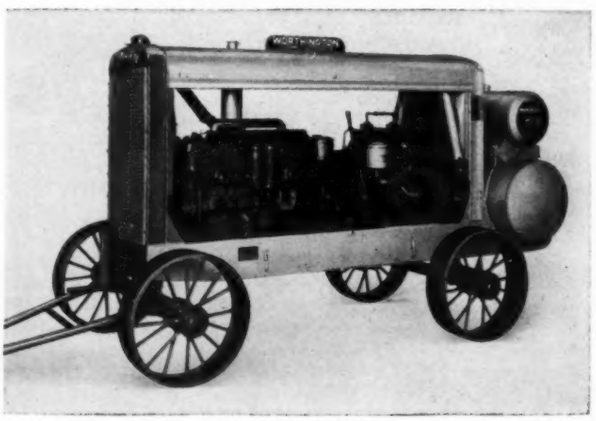
Portable Air Compressors in Four Sizes and Numerous Mountings

Four models of Aero-2-Stage portable compressors for delivering 105, 160, 210, and 315 cubic feet of actual air per minute (A. S. M. E. standard test), for use by builders, contractors, railroads, mines, utilities, and others, are now offered by the Worthington Pump & Machinery Corporation, Harrison, N. J.

Advanced design features throughout insure efficiency and endurance with lowest fuel and maintenance cost. The 105, 160, and 210 models are compact, convenient and complete compressed air plant units. They are balanced-angle, two-

stage, air-cooled,unit-assembly, with clutch connection to heavy-duty 6-cylinder gasoline engines. Speed, 830 r.p.m. Air pressure, 100 lb. gauge. Bores, strokes, and number of cylinders differ in the various models. The compressors are equipped with improved Feather Valves, ring-type cooling fins, articulated connecting rods, drop-forged crankshaft, Timken roller



New Worthington Portable Air Compressor

bearings, spray and force-feed lubrication, oil filter, and V-belt-driven cooling fan. The engines are Hercules, heavy duty, with 7-bearing crankshaft, removable cylinder sleeves, exhaust valve inserts, permanent oil filter, fuel strainer, roller bearing V-belt-driven fan, and other modern features. Mounting of the unit depends upon requirements and size. Thus the 105 model may be had as follows: skid-mounted; steel wheel; solid rubber or pneumatic tired towabout; four-wheel solid rubber or pneumatic tired spring trailer; two-wheel, single-axle spring trailer with solid rubber or pneumatic tires; truck-mounted; power take-off drive; rail car; mine car.

WITH THE MANUFACTURERS

Havana Metal Wheel Company Expands Under New Management

The Havana Metal Wheel Company, Havana, Ill., has enlarged its office quarters and is installing new, improved machinery in a program of expansion and redesign. Wheels of both the reinforced-forged-spoke and chilled-hub types will continue to be made, according to W. F. Heesch, president and general manager.

Redesign of product and production control is directed by E. E. Einfeldt, vice-president in charge of engineering. Both he and Mr. Heesch recently came to the Havana firm upon acquiring substantial proprietary interests, thereby severing a generation of connection with French and Hecht, where they were chief engineer and general manager, respectively.

Reflecting their activities in research into the dynamic behavior of spoked steel wheels, they are building forged-spoke wheels with the reinforcing shoulder in the form of a gradual-taper cone that distributes stresses, takes advantage of the elastic properties of the steel, and minimizes fatigue effects at this critical point. The hub holes are modified to provide proper filleting at changes in spoke section.

Another Havana development is a pneumatic tire rim in three pieces—a flat-faced central portion into which the spokes are swaged, and a bolted ring, bearing the flanges, on each side. It avoids the difficulties presented by drop-center rims in mounting or removing tires as used on tractors and other units having little clearance under fenders or other parts.

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Foote Co. Moves Chicago Office

The Foote Co., Nunda, N. Y., has announced a change in its Chicago office address. The new address will be 2139 West Fulton St., Chicago, Ill. Both day and night service will be available, and a complete stock of parts for both Multi Foote concrete pavers and Adnun black top pavers will be maintained

W. P. Jones

Joins "Caterpillar" Sales Force

A veteran in both engineering and sales experience, W. P. Jones, formerly northwestern representative for the J. D. Adams Company, Indianapolis, Ind., has joined the sales force of Caterpillar Tractor Company, where he will specialize in governmental and construction sales.

Mr. Jones represented the Adams Company in the Northwest during the last eight years, and for the eight years preceding that period was county engineer in Idaho in charge of construction and maintenance. He is well known throughout the West, where he took an active part in tests of construction equipment for government purchase. Due to his familiarity with conditions in the West, he will be assigned to that division by "Caterpillar." His headquarters will be at Spokane, Wash.

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W. Bruce Caldwell Now Works Manager of Calumet Steel

W. Bruce Caldwell has been named works manager of the Calumet Steel Company, recently acquired subsidiary of Borg-Warner Corporation, of Chicago Heights, Ill., according to an announcement by Roy C. Ingersoll, president.

Mr. Caldwell has been associated with the steel industry since his graduation from the School of Mechanical Engineering of Cornell University in 1912. After graduating from college he was connected with the National Malleable and Castings Company in Sharon, Pa., until the outbreak of the World War, during which he served in the Aviation Division of the United States Navy.

Mr. Caldwell was connected with the Sharon Steel Hoop Company of Sharon, Pa., from 1919 until 1933, serving as general superintendent of all of the plants of that company.

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Ransome Has Eight New Distributors

New distributors recently announced by Ransome Concrete Machinery Company, Dunnellen, N. J., are as follows: Hennessey-Forrestal Machinery Company, 900 Wainwright Building, St. Louis; Cauble Tractor & Equipment Company, 418 West Front Street, North Platte, Neb.; W. J. Holliday & Co., Indianapolis and Hammond, Ind.; Morrow & Co., Albuquerqe, N. M.; Lorenz Equipment Company, 337 South High Street, Columbus, Ohio; Minn-Dak Tractor & Equipment Company, 1200 Front Street, Fargo, N. D.; Wilson Machinery & Supply Company, 139 North Mill Street, Lexington, Ky.; Mine & Smelter Equipment Company, 110 South Third Avenue, Phoenix, Ariz.

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Bucyrus-Erie Names New Distributors in Iowa and Florida

Bycyrus-Erie Company, South Milwaukee, Wis., announces the appointment of Haight Tractor and Equipment Company, 1214 Mulberry Street, Des Moines, Iowa, as distributor in the central and eastern portions of Iowa and the Florida Machinery Corporation, 2315 North Miami Avenue, Miami, Fla., as distributor in the southern portion of Florida. These companies will handle Bucyrus-Erie machines ranging from ⅜- to 2-yard capacity—shovels, draglines, cranes, clamshells, drag-shovels and skimmer scoops. A branch office of the Haight company is maintained at Clinton, Iowa.

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Republic Steel Opens New Sales Office in Kansas City

Opening of a new sales office at 622 Dwight Building, Kansas City, Mo., effective September 1, is announced by N. J. Clarke, vice president in charge of sales, Republic Steel Corporation, Youngstown, Ohio. The new office will be in charge of Robert L. Pierce, of the St. Louis district sales office. The telephone number of the new office will be Harrison 0925.

Burford-Toothaker Company Now Distributors for Chain Belt in Alabama

The Chain Belt Company, Milwaukee, Wis., announces the appointment of Burford-Toothaker Tractor Company of Montgomery, Ala., as the exclusive distributor of Rex construction equipment in that territory.

The Burford-Toothaker Tractor Company has been connected with the construction machinery industry for a long time, Mr. Toothaker having been identified with the industry for many years. The company maintains a warehouse at Montgomery with a stock of Rex Mixers and Rex Pumps, and also a complete line of contractors' equipment.

The Rex line of construction equipment that will be handled by this company consists of pavers, mixers, centrifugal pumps, plaster and mortar mixers, cold patch mixers, diaphragm pumps, central mixing plants, and the pumpcrete (the pump that pumps concrete).

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Commercial Shearing and Stamping Co. Wins Suit on 3-Way Dumping Patents

The Commercial Shearing & Stamping Company, Youngstown, Ohio, which holds patents on a 3-way hydraulic pumping system for truck bodies, announces that its patents were recently held valid in a federal court decision. The company brought suit against Gar Wood Industries, Inc., of Detroit, Mich., and also against Dutchess County, New York, for infringement of patent; verdicts favorable to the Commercial company were given, in consent decrees, in each case.

The favorable court decisions were obtained after prolonged litigation in the courts and are considered highly valuable, states Charles B. Cushwa, president of the Commercial company. The 3-way, he says, offers contractors greater flexibility in their truck equipment than was heretofore possible, and gives such contractors a better competitive position on many important jobs.

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Four New Distributors for C. H. & E.

The C. H. & E. Manufacturing Company of Milwaukee, Wisconsin has announced the appointment of the following companies as exclusive distributors of C. H. & E. Saw Rigs, Pumps, Hoists, and Mortar Mixers:

The Albany Construction Equipment Company, 137 South Allen St., Albany, N. Y., in northeastern New York state.

Brown and Sites Company, 30 Church St., New York City, in the Metropolitan New York area and the state of Connecticut.

The Paving Supply & Equipment Company, 10th and Girard Sts., N. E., Washington, D. C., in the District of Columbia and eastern Maryland.

H. B. Fuller Equipment Co., 1836 Euclid Ave., Cleveland, Ohio, in northeastern Ohio.

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J. G. Hoag to Manage Osgood's Philadelphia Office

J. G. Hoag, who has been identified with the Osgood interests for upwards of fifteen years, and who has been connected with the Philadelphia office of that company, has been appointed manager of the Philadelphia branch, located at 236 North 23rd Street, Philadelphia, Pa.

Mr. Hoag has had a broad and varied experience in the field of excavating machinery, having been among the first to introduce Osgood revolving type shovels, cranes and draglines, in the Eastern Seaboard territory.

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Ryerson Now Director New York Life

Mr. Edward L. Ryerson, Jr., president of Joseph T. Ryerson & Son, Inc., large steel service organization, was recently elected to the board of directors of the New York Life Insurance Co. Mr. Ryerson succeeds Alba B. Johnson of Philadelphia, who died recently. In addition to his active service as president of the steel company, Mr. Ryerson is also a director of the Northern Trust Co. of Chicago, Quaker Oats Co., a trustee of the University of Chicago, and president of the United Community Fund of Chicago, Inc.

NEW LITERATURE

Public Works Engineers' Year Book, 1935.—Proceedings of American Society of Municipal Engineers, International Association of Public Works Officials, National Congress on Public Works and Municipal Engineering, held at Rochester, N. Y., Sept. 24-28, 1934. 302 pp., 5½ x 8½ in., cloth bound. Published by the Joint Secretariat, 850 East 58th St., Chicago, Ill. Contains papers and discussions on professionalizing public works, public works management, city planning and housing, work relief problems, street construction and maintenance, street finance and accounting, refuse disposal, sewerage and sanitation developments, public utilities, municipal field engineering, airports and landing fields, traffic control, street lighting, engineers in the depression, specifications for pavements, curbs, and sidewalks, and other material. Membership rosters are also included.

Colas Asphalt Roads. This 40 page booklet issued by the Asphalt Department of the Shell Eastern Petroleum Products, Inc., contains a comprehensive discussion of the various uses of Colas—an asphalt emulsion—of much interest to highway officials and contractors. It contains a description of the Colas construction principles, and a summary of construction specifications and quantities. It also includes sections on penetration specifications, road mix specifications, plant mix specifications, reconditioning and maintenance, light resurfacing specifications, Colas patching and repairs, Terolas sand and dirt mix construction, colas surfaces for airports, Colas driveways, foot paths and tennis courts, Colas emulsion specifications and miscellaneous data. Copies of the booklet can be obtained by addressing ROADS AND STREETS, 155 East 44th St., New York City.

Cement and Concrete Reference Book. A 32-page booklet just issued by Portland Cement Association, 33 West Grand Ave., Chicago, Ill., giving a wide range of information on the cement industry in the United States—history, number of plants in cement and allied industries, description of manufacture, production in U. S. and other countries by years, use of cement by states, value, comparative price indices, area of concrete pavement each year since 1909, mileage and other road data by states, Federal aid for highways, pavements in cities, road costs, diversion of motor taxes, maximum street grades in cities, road maintenance costs, automobile operating costs, tractive resistance, airports, etc.

Steel Bearing Piles. This publication of the Carnegie Steel Company, while gotten up in the general style of a commercial catalog, is in many respects more of the nature of a handbook. Its 78 beautifully illustrated pages contain matter on the history of steel piles, engineering formulas and design data, driving equipment, test data and methods, corrosion resistance and protection, and subdivisions of these subjects. There are numerous line cuts showing layouts and details of design. The data tables present their subject matter in exceedingly clear and usable form. No charge is made for the publication, and copies may be obtained either from the Carnegie Steel Co. or the Illinois Steel Co.

Effect of Time Yield in Concrete Upon Deformation Stresses in a Reinforced Concrete Arch Bridge.—A 32-page illustrated report of an investigation conducted by the Engineering Experiment Station, University of Illinois, in cooperation with the United States Bureau of Public Roads, by Wilbur M. Wilson and Ralph W. Kluge. Bulletin No. 275, Engineering Experiment Station. Published by the Univerity of Illinois, Urbana. Price: Forty Cents.

Waterproofing and Dampproofing at Grade Separations. A brief technical report covering information necessary in specifying or applying waterproofing or dampproofing on grade crossing elimination projects has just been prepared by the Technical Department of the Koppers Products Company, Pittsburgh. It tells the different kinds of treatments necessary for different types of problems. Copies may be secured without charge.

Proceedings of the 14th Annual Meeting of the Highway Research Board held at Washington, D. C., December 6-7, 1934. Edited by Roy W. Crum, Director of Highway Research Board. 482 pages, 7 x 9½ in., paper cover, published by the Highway Research Board, National Research Council, 2101 Constitution Avenue N. W., Washington, D. C. Price $2.00.

Contains ten papers on highway transportation economics, 7 papers on design, 3 papers on materials and construction, and 9 papers on traffic, together with committee reports and discussions.

Trucks and Road Maintainers. Two booklets recently issued by the Four Wheel Drive Auto Company, Clintonville, Wisc., describe respectively models LM and HM road maintainers, and the Model HS, 1½-ton truck.

The 12 pages of the first of these pamphlets contain descriptive views and comprehensive detail showing the use of the FWD trucks equipped with underbody scrapers for road maintenance.

The second booklet, also of 12 pages, gives illustrations and descriptive details, pointing out the capacity of the Model HS trucks for performance, speed and economy.

Baker Gradebuilders and Bulldozers for Allis-Chalmers Tractors. Two bulletins of the Baker Manufacturing Co., Springfield, Ill. Bulletin No. 553 contains 8 pages of text and illustrations, together with specifications for hydraulic operated grade builders with Allis-Chalmers tractors. Bulletin No. 554 describes twin cylinder, direct lift bulldozers, also for Allis-Chalmers tractors. This pamphlet contains 24 pages with many illustrations, specifications and descriptive and explanatory matter.

The Chemistry of Cement and Concrete, by F. M. Lea and C. H. Desch. 430 pages, 6 x 9 in., cloth bound, published by Longmans, Green and Company, 114 Fifth Avenue, New York. Price $9.50.

It is impossible in the space available to give an adequate review of this book. It contains 22 chapters with the following headings:

1. The History of Calcareous Cements.
2. Classification of Cements.
3. The Raw Materials and Processes of Manufacture of Portland Cements.
4. Cement Components and Their Phase Relations.
5. The Cementing Qualities of the Cement Compounds.
6. The Constitution of Portland Cement.
7. The Burning of Portland Cement.
8. The Proportioning of Portland Cement.
9. The Hydration of Portland Cement.
10. The Setting and Hardening of Portland Cement.
11. The Action of Acid and Sulphate Waters on Portland Cement.
12. The Physical and Mechanical Properties of Portland Cement.
13. Pozzolanas and Pozzolanic Cements.
14. Cements Made From Blast-Furnace Slag.
15. Aluminous Cement.
16. Aluminous Cement (Cont.).
17. Some Special Cements and Cement Properties.
18. Concrete Aggregates.
19. The Resistance of Concrete to Natural Destructive Agencies.
20. The Resistance of Concretes to Various Organic and Inorganic Agents.
21. The Examination of Concrete Failures.
22. Conclusion, Appendices, References, Name Index, Subject Index.

The numerous diagrams are all clear and understandable, while the halftones are of extraordinarily fine quality—especially those showing microscopic sections. A very complete subject index is a distinct asset. There is also a name index of all authorities quoted. Typography and composition are excellent, and the whole volume is of a workmanlike character, which makes it a pleasure to handle.

ROADS AND STREETS

with which is merged Good Roads and Engineering and Contracting.
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